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SECOND ANNUAL REPORT
OF THE
STATE DEPARTMENT OF HEALTH
OF
MASSACHUSETTS.

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SECOND ANNUAL REPORT

OF THE

STATE DEPARTMENT OF HEALTH

OF

MASSACHUSETTS.

For the fiscal year ending Nov. 30, 1916, the State Department of Health was constituted as follows: —

Commissioner of Health, ... ALLAN J. MCLAUGHLIN, M.D.

PUBLIC HEALTH COUNCIL.

ALLAN J. MCLAUGHLIN, M.D., *Chairman.*

WM. J. GALLIVAN, M.D., 1919.	JOSEPH E. LAMOUREUX, M.D., 1918.
JOHN T. WHEELWRIGHT, 1919.	GEORGE C. WHIPPLE, S.B., 1917.
DAVID L. EDSALL, M.D., 1918.	WM. T. SEDGWICK, PH.D., 1917.

During the year seventeen formal meetings of the Council were held, and in addition numerous committee meetings.

In accordance with section 2, chapter 792 of the Acts of 1914, at a meeting of the Public Health Council on Jan. 16, 1916, the Commissioner of Health submitted to the Council a report of the work of the Department for the fiscal year 1916, together with recommendations for legislation, and it was voted that this report be approved and adopted as the report of the State Department of Health for the fiscal year 1916.

REPORT OF THE COMMISSIONER OF HEALTH.

In accordance with chapter 792 of the Acts of 1914 I have the honor to submit the following report of the work of the State Department of Health for the fiscal year 1916.

The organization of the Department into seven divisions was continued throughout the year, and for the present I recommend no change.

There were some changes in personnel. Pressure of other duties compelled Prof. S. M. Gunn to resign as director of the Division of Hygiene, and his resignation was accepted with regret.

The vacancy caused by Professor Gunn's resignation was filled by the promotion of Dr. Lyman A. Jones, one of the District Health Officers, to the post of director of the Division of Hygiene, so that the present list of divisions and their directors is as follows: —

Division of —	Director.	Salary.
Administration,	L. A. Jones, M.D. (acting),	-
Sanitary Engineering,	X. H. Goodnough,	$5,000
Water and Sewage Laboratories,	H. W. Clark,	4,000
Food and Drugs,	H. C. Lythgoe,	3,500
Communicable Diseases,	E. R. Kelley, M.D.,	4,000
Biologic Laboratories,	M. J. Rosenau, M.D.,	1,500[1]
Hygiene,	L. A. Jones, M.D.,	3,500

[1] Part time.

These divisions are all in charge of expert officials, and all but one gives full time to the work. Dr. M. J. Rosenau, in charge of the Biologic Laboratories, gives but part time to the work, and the Department is very fortunate to be able to secure his highly technical and expert supervision over the laboratory products for the modest sum of $1,500.

The Department has been seriously hampered by lack of space in the past two years, especially in the laboratory work. The laboratory units are all growing, and must have space for expansion. These needs have been explained repeatedly to the Governor's Council and to the State House Commission. Better accommodations and more space have been furnished for the Divisions of Administration, Hygiene and Communicable Diseases, but no relief has been given to the laboratories, where the need is most pressing. There are six separate laboratory units, as follows: —

Laboratory.	Location.
Water and Sewage Laboratory,	State House.
Lawrence Experiment Station,	Lawrence.
Diagnostic Laboratory,	State House.
Antitoxin and Vaccine Laboratory,	Forest Hills.
Wassermann Laboratory,	Harvard Medical School.
Food and Drug Laboratory,	State House.

The ideal solution of the laboratory problem would be to secure quarters for all six of these units under one roof as a Division of Laboratories. This would facilitate administration and secure more prompt and efficient service.

Division of Administration.

The Division of Administration has been conducted along the lines indicated in the last report of the Department. Central buying is insisted upon, and all divisions are required to make a property return. The estimates for this Division have been made under the heading of general expenses, and this item includes the running expenses of this Division only.

Division of Sanitary Engineering.

The Division of Sanitary Engineering continued its good work during 1916. One hundred and fifty-four applications for advice to cities and towns in regard to water supplies and sewerage and allied problems were acted upon. All sewer outlets discharging into the sea or tidal waters were examined during the year. Over 300 sources of water supply for towns, cities and fire districts have been controlled by analyses. Many inspections of sewerage systems and sewage disposal works in the State were made by this Division, and a continued supervision maintained over the water courses to protect against pollution. The details of these various activities are fully covered in the report of the director of the Division of Sanitary Engineering, to be found in the supplement.

Division of Water and Sewage Laboratories.

The Division of Water and Sewage Laboratories performs all laboratory work required under the statutes governing the purity of inland waters. It also makes extensive investigations and does analytical work in problems of water supply, sewage disposal and trades wastes disposal. In the past year over 6,000 samples of water, sewage, effluents, factory wastes, etc., were analyzed in these laboratories, and bacteriologic examinations of over 4,000 samples were made. Many interesting investigations were made on the activated sludge process, the sterilization of clams and oysters with hypochlorite, the radio activity of water, etc. Details of the work of this Division will be found in the report of the director.

DIVISION OF FOOD AND DRUGS.

The Division of Food and Drugs continued its commendable work under the statutes covering food and drugs, including milk, cold-storage products and meat-slaughtering inspection. Over 11,000 samples of milk, food and drugs were examined during the year. One hundred and ninety-six prosecutions were made, 175 of which resulted in convictions. A full description of this work will be found in the report of the director of this Division, in the supplement.

Besides the routine work of the Division, a large amount of work was done in attempting the manufacture of dioxy-diamino-arseno-benzol, or allied substances, for the treatment and cure of syphilis. The researches promise success, and if successful will have a greater effect upon the problem of syphilis than any other known procedure. The manufacture of this or allied substances, as provided by chapter 47 of the Resolves of 1916, necessitated the assistance of eminent consulting experts. Prof. Samuel W. Mulliken was appointed as consulting expert in organic chemistry on July 1, 1916, and Prof. Reid Hunt was appointed as consulting expert in pharmacology on Oct. 1, 1916, in order to properly control the experiments.

DIVISION OF COMMUNICABLE DISEASES.

The Division of Communicable Diseases has made notable improvements during the year in the methods of control over communicable diseases. In this Division there is now established an endemic index for each of the important diseases for each community in the Commonwealth. By a glance at this index any unusual prevalence is apparent, and prompt investigation reveals whether it is a mere coincidence or the beginning of an outbreak.

Much better reporting by physicians is evident, and calculations based on the ratio of deaths to reported cases seem to indicate that Massachusetts physicians report more thoroughly than those of other States.

A splendid spirit of co-operation is evidenced also by the local boards of health, who report not only to the Department but also to the District Health Officer of their district.

A very great improvement has been effected in morbidity and mortality returns through the office of the Secretary of State. Through the co-operation of the Bureau of Vital Statistics of that office complete returns are now placed at the disposal of the Department within one month, while formerly these were not available for perhaps two years. This readjustment involved much work for the Bureau of Vital Statistics, and is a demonstration of courteous co-operation which is very gratifying.

The diagnostic laboratory is overworked, and only by means of considerable overtime work is the present organization able to respond to the demands made upon it. It is also suffering from lack of space, and the cramped quarters are a detriment to the health and efficiency of the personnel.

In round numbers there were examined, in 1914, 11,000 specimens; in 1915, 17,000; in 1916, 22,000. With an appropriation of $5,700, this means that in 1916 the cost per specimen was only 26 cents.

The District Health Officers continued their admirable work of the previous year, and the value of this highly efficient corps of full-time sanitary experts has been demonstrated repeatedly in incipient epidemics, and in handling the vexatious quarantine problems arising out of the epidemic of poliomyelitis.

Division of Biologic Laboratories.

The scope of the work of the biologic laboratories was enlarged during the year. The work of examination of dogs for rabies, and the complement fixation test for glanders, have been done for the Bureau of Animal Industry.

There were distributed by this Division during the past year about 175,000 doses of diphtheria antitoxin, 1,696 doses of anti-meningitis serum, 130,000 doses of vaccine virus, and 46,000 doses of typhoid prophylactic.

For the Bureau of Animal Industry over 1,000 tests were made, including 985 complement fixation tests for glanders and 47 examinations for rabies.

Over 25,000 tests for the Wassermann reaction were made during the year, and the cost of this highly technical and delicate test is thus reduced to less than 20 cents per test.

It is probable that the General Court will further expand the work of this Division in response to the demand for certain other sera and diagnostic procedures. The manufacture and distribution of an anti-pneumococcic serum, and the furnishing of complement fixation tests for tuberculosis, will probably be added to the functions of this Division within the next year.

Division of Hygiene.

Over 60 per cent. of the health officer's problems is due to diseases which can be reduced in prevalence only by means of education in personal hygiene. Educational methods alone promise results in infant mortality, cancer and diseases of the circulatory and urinary systems.

We have reached a point in our work against the communicable diseases where further reduction in the death rates thereof depends almost entirely upon education of the individual citizen. This work is being carried on by the Division of Hygiene.

All recognize the danger from communicable diseases and the value of efforts to prevent them. All do not yet realize in equal degree the economic loss resulting from sickness in general, the high infant death rate, children poorly born and handicapped in physical and mental development, school children below par and unable to keep up with the normal child, individuals needlessly incapacitated by organic diseases of the heart, blood vessels and kidneys, in considerable part the result of faulty living, and the loss to the community of lives from such diseases as tuberculosis and cancer because of the failure to detect these diseases in their early stages when prospect of recovery is most promising.

The solution of the problem lies in bringing this knowledge to people in general, and showing how these conditions may be overcome. This can best be accomplished by the work of properly trained persons who can do intensive work in the communities throughout the State, interesting children in the schools, teachers, parents, clubs and other organizations in individual places, and by means of lectures, exhibits and pamphlets for general distribution. Such work cannot fail to have far-reaching influence and results.

The Division of Hygiene, with 60 per cent. of the health problem, was financed last year on 7 per cent. of the total Health Department appropriation. This year the Department is asking for $25,000, or less than 10 per cent. of the total estimates for the Department, for carrying on the work of this Division.

Although hampered by lack of funds, a great deal of work was accomplished in this Division in 1916. Six hundred and twenty-eight lectures were given, and nearly 100,000 persons attended these lectures. One or more lectures were given in 183 of the cities and towns in the Commonwealth. Moving-picture health films were exhibited 372 times in response to requests from boards of health and others interested in the teaching of hygiene.

The child welfare health exhibit was shown in 24 different cities and towns in the State. This exhibit teaches, in an interesting way, the importance of healthy parents, the desirability of breast feeding, the necessity for clean milk, fresh air and daily baths. It also shows the dangers of patent medicines and soothing syrups. With the exhibit which usually forms a feature of a "health week," literature is distributed relating to child welfare.

In spite of the greatly increased work of the Department in the past year, much remains to be done in combating some of the greatest factors in our death rate. Attention is called to the work and plans of the new Division of Hygiene for reducing infant mortality and for standardizing and improving the work of medical school inspection. We should not relax our work on these lines until a much more satisfactory status is reached.

Infant Mortality.

The infant mortality rate is steadily decreasing, but the decrease is largely due to the good work done in the larger cities. Forty per cent. of infant deaths occur in the first month, and this indicates clearly that prenatal causes are a very potent factor. More prenatal work must be done, especially in the smaller cities and towns. The infant mortality rate in some of these smaller communities is high enough to warrant the employment of a full-time public health nurse for this kind of education alone. In many other towns a visiting nurse should be employed who would devote part time to prenatal work and part time to school hygiene and tuberculosis work.

School Hygiene.

The aimless efforts at school hygiene under the law providing for medical inspection of schools are pitiful in their lack of purpose and uniformity. In many of the smaller places the compliance with this law is the veriest farce. In others there is good effort, but the opportunity for improving the physical status of the school child without obvious defect is not realized. In such communities a perfunctory examination is made for certain defects and contagious diseases, but no effort beyond this is apparent.

There should be a physical and mental survey of every school child made at least once each year and recorded on a card, together with the outline or prescription of hygienic treatment necessary to bring the child to the normal or maintain it at the normal. Not only children with defects should be so surveyed and prescribed for, but also those below normal in physique or mental equipment.

Sixty per cent. of our school hygiene problem is rural, or consists of communities with populations of less than 2,500. In these, medical inspection and school nurse work can best be done by the appointment of district physicians and nurses on a plan similar to that upon which school superintendents are employed.

TUBERCULOSIS.

The tuberculosis campaign of the Department has made great strides in the past year. The greatest possibility in the prevention of tuberculosis, that is, through the school child, will not be realized until we have a uniform scientific system of inspection of school children, as outlined above under school hygiene.

All cities and towns of more than 10,000 population are now complying with the law to provide a tuberculosis dispensary satisfactory to the Department. This has resulted in the establishment of a splendid corps of dispensary nurses who meet once a month and exchange ideas and experiences.

The passage of the county tuberculosis hospital act last year completes the Department's plans for institutional treatment, and when the provisions of this act are carried out, and Lowell and Brockton comply with the law covering their cases, there will be hospital beds sufficient to care for every open case of tuberculosis in the Commonwealth.

Besides the direct attack on tuberculosis through the school child, which should be pushed much more vigorously, there remains one other help which the State may properly furnish, viz.: the complement fixation test for diagnostic purposes.

COMMUNICABLE DISEASES OF CHILDHOOD.

In the ordinary diseases of childhood — measles, whooping cough and scarlet fever — health officials are doing everything possible in an official way, so that still further reduction in these diseases will depend largely upon education of the individual citizens, with the hope of obtaining their co-operation.

Diphtheria should be reduced more rapidly in view of the fact that we have a specific, which, given early and in proper dosage, makes a fatal issue almost impossible. An investigation of every death from diphtheria in the past year shows that the main cause is failure to call a physician early, and as a consequence in these cases antitoxin is administered too late to be effective. Here, again, the remedy must be educational.

ANTERIOR POLIOMYELITIS.

The occurrence of an epidemic of anterior poliomyelitis, totaling about 1,900 cases, occupied a large part of the time and attention of the Department during the last five months of the year.

Complete statistical data for every case which occurred in the

Commonwealth have been collected, and this information is now being analyzed with a view to publication later on in the form of a special report.

Full details of the outbreak are given in the report of the director of the Division of Communicable Diseases, to be found in the supplement.

PNEUMONIA.

Pneumonia, taken collectively in all forms, is the greatest single factor in our death rate. Lobar pneumonia alone causes over 3,000 deaths in Massachusetts annually, and ranks second only to tuberculosis among the communicable diseases as a cause of death; yet health officials have done practically nothing to reduce this scourge.

Lobar pneumonia should be placed on the list of diseases whose reporting is compulsory. There is no more reason for not regarding this disease as a dangerous communicable disease than there would be for neglecting to so regard diphtheria or tuberculosis, and no significant reduction is likely to be noted in the prevalence of this disease until it is so regarded.

In view of the researches made in the manufacture of anti-pneumococcic serum, and of the effect of such serum, it would seem wise to manufacture and distribute free an anti-pneumococcic serum to physicians for use in the Commonwealth.

SYPHILIS.

To effectually combat syphilis, facilities for the diagnosis thereof must be placed at the disposal of hospitals, dispensaries, health boards and physicians. Effective treatment should also be made available either free or at a reasonable price. This Department has put the first measure into effect, and has made good progress toward the second.

Over 25,000 Wassermann tests were made in the Wassermann Laboratory last year free of charge, at an expense to the State of less than 20 cents per test.

The General Court of 1916 authorized the expenditure of $10,000 for research to produce a substance similar or analogous to salvarsan for free distribution in the Commonwealth, and although only about $1,000 has been expended the Department has every reason to believe that a product which will render the syphilis carrier non-infective will be produced in the near future.

FINANCIAL.

Every division in the Department kept well within the bounds of its appropriation, and the Division of Administration turned back into the treasury over $1,500. As a result, the estimates for 1917, although providing for additional functions and increased work, will not exceed the amount available in 1916.

LEGISLATIVE RECOMMENDATIONS.

1. An act relative to the State Department of Health.
2. A resolve providing for the manufacture and distribution of an anti-pneumococcus serum.
3. An act amending sections 2 and 9 of chapter 286 of the General Acts of the year 1916, providing for the construction by counties of tuberculosis hospitals for cities and towns having less than 50,000 inhabitants.
4. An act amending section 4 of chapter 537 of the Acts of the year 1907, providing that the reports of the District Health Officers should be submitted on the first day of December.
5. An act amending section 53 of chapter 75 of the Revised Laws relative to the reimbursement from the State, through the State Board of Charity, to cities and towns for expenses incurred in the care of unsettled or State cases suffering from diseases dangerous to the public health.
6. An act establishing grades of milk.
7. An act relative to the pasteurization of milk.
8. An act relative to the protection of the milk supply.
9. An act amending sections 16, 18 and 24 of chapter 75 of the Revised Laws relative to the adulteration of food.
10. An act amending chapter 652 of the Acts of the year 1912 relative to the cold storage of foods.

APPROPRIATIONS.

Regular.

The figures in the case of the antitoxin and vaccine appropriation are not final, for the reason that there are several bills still outstanding. Although the goods in some instances were ordered as far back as the summer of 1916, on account of the rush of business and very serious delays in transportation they have not yet been received. We are promised delivery now at almost any time. These goods were mostly apparatus and laboratory supplies.

The appropriations for the year ended Nov. 30, 1916, as recommended by the Commissioner of Health in the annual estimates made under the provisions of chapter 6, section 26, of the Revised Laws, were as follows: —

For the salary of the Commissioner of Health,	$7,500 00
For the general expenses of the Department,	18,240 00
For printing the annual report,	4,000 00
For the Division of Hygiene,	14,300 00
For the salary of the director of the Division of Communicable Diseases,	4,000 00
For the salary and expenses of an epidemiologist,	3,000 00
For the State Inspectors of Health,	38,800 00
For the maintenance of a diagnostic laboratory,	5,730 00
For the production and distribution of antitoxin and vaccine,	29,000 00
For the prevention of ophthalmia neonatorum,	1,000 00
For the salary of the director of the Division of Food and Drugs,	3,000 00
For the inspection of food and drugs,	17,500 00
For slaughtering inspection and cold storage,	12,000 00
For water supply and sewage disposal,	56,800 00
For the State Examiners of Plumbers,	5,200 00
Total,	$220,070 00

Special Appropriations.

For the prevention and suppression of syphilis,	$10,000 00	
For an investigation of non-pulmonary tuberculosis,	500 00	
For printing a report relative to the production and sale of milk,	700 00	
		11,200 00

Emergency Appropriations.[1]

For work in connection with the epidemic of infantile paralysis,	$5,000 00	
For after-care work in cases of infantile paralysis,	5,000 00	
		10,000 00
		$241,270 00

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[1] Transferred by the Governor and Council from their appropriation for extraordinary expenses.

EXPENDITURES.

The expenditures under the different appropriations for the year ended Nov. 30, 1916, were as follows: —

REGULAR APPROPRIATIONS.

General Expenditures.

Appropriation,	$18,240 00
Credit by transfers to other appropriations,	2,936 51
By brought over from 1915 appropriation,	3 85
	$21,180 36

Salaries,	$10,548 55
Traveling,	920 99
Express,	320 54
Printing and binding,	1,083 60
Books and subscriptions,	296 55
Advertising,	168 63
Stationery, maps and blue prints,	418 83
Postage and postal orders,	2,048 49
Telephone and telegraph messages,	363 41
Typewriting supplies and repairs,	470 91
Laboratory supplies,	289 22
Sundry office supplies,	197 45
Health Council, per diem,	1,450 00
Extra services,	175 65
Messenger,	185 28
Miscellaneous,	72 42
Total,	$19,010 52
Unexpended balance,	2,169 84
	$21,180 36

Division of Hygiene.

Appropriation for the year ended Nov. 30, 1916,	$14,300 00
Credit by cash returned to treasury,	2 00
	$14,302 00

Salaries,	$6,803 69
Traveling,	1,237 12
Express,	241 54

Printing and binding,	$3,697 97
Books and subscriptions,	10 20
Advertising and educational work,	1,343 52
Stationery, maps and blue prints,	110 34
Postage,	457 88
Telephone and telegraph,	14 55
Typewriters, supplies and repairs,	272 08
Extra services,	67 19
Miscellaneous,	7 27
Total,	$14,263 35
Unexpended balance,	38 65
	$14,302 00

Expenditures for the Salary and Traveling Expenses of an Epidemiologist.

Appropriation for the year ended Nov. 30, 1916,	$3,000 01
Salaries,	$2,502 29
Traveling,	277 19
Telephone,	10 04
Extra services,	194 25
Office supplies,	50
Total,	$2,984 27
Unexpended balance,	15 74
	$3,000 01

Expenses under the Provisions of the Act to provide for the Establishment of Health Districts and the Appointment of State Inspectors of Health (Chapter 537, Acts of 1907, Chapters 405 and 543, Acts of 1910, Chapters 603 and 609, Acts of 1911) for the Year ended Nov. 30, 1916.

Appropriation,	$38,847 21
Credit by transferred to appropriation for epidemiologist,	39 35
	$38,886 56
Salaries,	$26,339 45
Traveling,	7,489 91
Express,	23 11
Printing,	773 12
Books and maps,	148 40

Postage,	$490 53
Typewriting supplies,	351 32
Extra services,	1,087 34
Telephone and telegraph,	365 48
Office supplies and stationery,	497 38
Laboratory and experimental work,	22 08
Miscellaneous,	3 00
Total,	$37,591 12
Unexpended balance,	1,295 44
	$38,886 56

Expenditures for the Maintenance of a Diagnostic Laboratory for the Year ended Nov. 30, 1916.

Appropriation,	$5,730 00
Salaries,	$4,607 92
Laboratory supplies,	654 81
Printing,	192 07
Stationery,	8 40
Mailing cases,	223 35
Office supplies,	17 85
Traveling,	3 48
Purchase of animals,	13 95
Miscellaneous,	4 70
Total,	$5,726 53
Unexpended balance,	3 47
	$5,730 00

Expenditures for the Production and Distribution of Antitoxin and Vaccine for the Year ended Nov. 30, 1916.

Appropriation,	$29,000 00
Credit by check returned to treasury in settlement of damages by express company,	3 00
	$29,003 00
Salaries,	$14,042 44
Apparatus and chemicals and laboratory supplies,	5,262 75
Traveling,	47 67
Express,	113 71
Books and stationery,	115 44

Printing,	$524 13
Purchase of animals,	828 60
Horseshoeing,	31 47
Services of veterinary,	2 00
Feed for animals,	4,084 69
Rental of telephone, messages and postage,	267 97
Extra services,	298 17
Water, gas, electric lighting and heating,	553 26
Labor and materials,	206 70
Ice,	264 03
Rent,	2,058 32
Miscellaneous,	219 24
Total,	$28,920 59
Unexpended balance,	82 41
	$29,003 00

For carrying out the Provisions of the Act relative to the Prevention of Ophthalmia Neonatorum (Chapter 458, Acts of 1910).

Appropriation for the year ended Nov. 30, 1916,	$1,000 00
Printing,	$47 99
Ophthalmia outfits,	560 12
Mailing cases,	30 25
Total,	$638 36
Unexpended balance,	361 64
	$1,000 00

Expenditures under the Provisions of the Food and Drug Acts for the Year ended Nov. 30, 1916.

Appropriation,	$17,500 00
Salaries of analysts,	$5,671 67
Salaries of inspectors,	5,969 89
Salaries of office assistants,	1,219 17
Traveling expenses,	2,407 24
Purchase of samples,	434 62
Apparatus and chemicals,	684 57
Express,	10 34
Printing,	124 62
Books, maps and stationery,	235 59

Telephone and telegraph messages and postage,	$203 83
Sundry laboratory supplies,	102 54
Typewriting supplies and repairs,	151 52
Services (cleaning laboratory),	143 00
Extra services,	99 03
Miscellaneous,	25 45
Advertising,	10 05
Total,	$17,493 13
Unexpended balance,	6 87
	$17,500 00

For carrying out the Provisions of the Act relative to Slaughtering Inspection and the Inspection of Food Products treated by Cold Storage.

Appropriation for the year ended Nov. 30, 1916,	$12,000 00
Credit by paid to State treasury on account of sale of branding outfits,	74 20
	$12,074 20

Salaries,	$9,158 33
Traveling,	1,778 32
Printing,	156 88
Branding outfits,	96 55
Stationery and office supplies.	186 82
Telephone and telegraph,	19 10
Postage,	94 12
Extra services,	342 83
Typewriting supplies,	50 20
Apparatus and chemicals,	51 60
Miscellaneous,	20 09
Total,	$11,954 84
Unexpended balance,	119 36
	$12,074 20

For carrying out the Provisions of the Act to protect the Purity of Inland Waters, for the Examination of Sewer Outlets, and for the Examination of the Sanitary Condition of Certain Rivers and Water Courses.

Appropriation for the year ended Nov. 30, 1916,	$56,800 00
Credit by cash returned to treasury,	90
	$56,800 90
Salaries,	$43,399 04
Apparatus and materials,	3,648 06
Traveling,	5,023 54
Express,	1,510 12
Maps, blue prints and books,	236 84
Printing and binding,	837 19
Stationery, drawing materials and typewriting supplies,	442 63
Telephone and telegraph messages and postage,	261 02
Extra services,	199 88
Services, collecting samples and reading gauges,	699 85
Rent,	175 00
Miscellaneous,	189 46
Total,	$56,622 63
Unexpended balance,	178 27
	$56,800 90

State Examiners of Plumbers.

Appropriation,	$5,200 00
Salary of secretary,	$2,000 00
Examiners' wages,	535 00
Traveling,	429 12
Express,	34 01
Printing,	341 69
Postage,	168 50
Books and stationery,	32 00
Extra services,	1,129 35
Cleaning,	24 75
Office supplies,	4 60
Telephone and lighting,	38 95
Typewriter and repairs,	84 88
Labor and materials,	40 14
Miscellaneous,	4 75
Total,	$4,867 74
Unexpended balance,	332 26
	$5,200 00

SPECIAL APPROPRIATIONS.

Expenditures under the Provisions of the Act for the Prevention and Suppression of Syphilis (Chapter 47, Resolves, 1916) for the Five Months ended Nov. 30, 1916.

Appropriation,	$10,000 00
Salaries,	$625 83
Apparatus, chemicals and laboratory supplies,	150 57
Traveling,	30 47
Express,	2 22
Extra services,	300 00
Total,	$1,109 09
Unexpended balance,	8,890 91
	$10,000 00

Expenditures under the Provisions of the Resolve for an Investigation of Non-pulmonary Tuberculosis (Chapter 62, Resolves, 1916).

Appropriation,	$500 00
Salaries,	$334 52
Unexpended balance,	165 48
	$500 00

Expenditures under the Provisions of Chapter 150, Resolves, 1916, and Chapter 374, Special Acts of 1916, for printing a Report relative to the Production and Sale of Milk.

Appropriation,	$700 00
Expended for printing only,	$700 00

EMERGENCY APPROPRIATIONS.

For Work in Connection with the Epidemic of Infantile Paralysis, Month of November, 1916.

Appropriation,	$5,000 00
Salaries, November, 1916,	$203 33
Traveling,	201 87
Maps and stationery,	4 15
Postage,	99
Telephone,	10 58
Miscellaneous,	2 00
Total,	$422 92
Unexpended balance,	4,577 08
	$5,000 00

For Work in Connection with the After-care of Infantile Paralysis, Month of November, 1916.

Appropriation,	$5,000 00
Salaries, only,	$223 88
Unexpended balance,	4,776 12
	$5,000 00

Recapitulation.

Regular Appropriations.

	Appropriation.	Expended.
For the salary of the Commissioner of Health,	$7,500 00	$7,500 00
For the general expenses of the Department,	18,240 00	16,070 16
For printing the annual report,	4,000 00	4,395 92[1]
For the Division of Hygiene,	14,300 00	14,263 35
For the salary of the director of the Division of Communicable Diseases,	4,000 00	4,000 00
For the salary and expenses of an epidemiologist,	3,000 00	2,984 27
For the State Inspectors of Health,	38,800 00	37,551 77
For the maintenance of a diagnostic laboratory,	5,730 00	5,726 53
For the production and distribution of antitoxin and vaccine,	29,000 00	28,917 59
For the prevention of ophthalmia neonatorum,	1,000 00	638 36
For the salary of the director of the Division of Food and Drugs,	3,000 00	3,000 00
For the inspection of food and drugs,	17,500 00	17,493 13
For slaughtering inspection and cold storage,	12,000 00	11,880 64
For water supply and sewage disposal,	56,800 00	56,621 73
For the State Examiners of Plumbers,	5,200 00	4,867 74
Totals,	$220,070 00	$215,911 19

Special Appropriations.

For the prevention and suppression of syphilis,	$10,000 00	$1,109 09
For an investigation of non-pulmonary tuberculosis,	500 00	334 52
For printing a report relative to the production and sale of milk,	700 00	700 00
Totals,	$11,200 00	$2,143 61

Emergency Appropriations.

For work in connection with the epidemic of infantile paralysis,	$5,000 00	$422 92
For after-care work in cases of infantile paralysis,	5,000 00	223 88
Totals,	$10,000 00	$646 80
Grand totals,	$241,270 00	$218,701 60

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[1] Balance, $395.02, transferred by the Governor and Council from their appropriation for extraordinary expenses.

A. J. McLAUGHLIN, M.D.,
Commissioner of Health.

SUPPLEMENT.

DIVISION OF SANITARY ENGINEERING.

X. H. GOODNOUGH, *Chief Engineer and Director.*

REPORT OF THE DIVISION OF SANITARY ENGINEERING.[1]

The duties of this Division relate chiefly to carrying out the requirements of the general law, which provides that the State Department of Health shall have the general oversight and care of all inland waters of the Commonwealth, and the numerous special laws relating to that subject.

The general design of these laws is the guardianship of the public interest and the public health in its relation to water, whether it be the water of public water supplies, or of the lakes, ponds and rivers of the State, or of the bays and estuaries bordering its coast. In furtherance of this general design these laws provide that the State Department of Health may cause examinations of inland waters to be made to ascertain their purity and fitness for domestic use, or their liability to impair the interests of the public, or of persons lawfully using them, or to imperil the public health; that the Department may make rules and regulations to prevent the pollution and secure the sanitary protection of all such waters as are used as sources of water supply; and, finally, that the Department shall consult with and advise cities, towns and persons as to water supply, drainage, sewerage and the disposal of manufacturing waste in order to secure the protection of all the inland waters of the State and their best development in the public interest. The principal duties of the Department under these laws may be briefly summarized as follows: —

1. Advice to cities, towns and persons relative to water supply, drainage, sewerage and the treatment and disposal of manufacturing waste, including the consideration of plans relating to such projects presented for the approval of the Department under numerous special laws.
2. Examination of water supplies.
3. Examination of rivers and other inland waters.
4. Examination of sewer outlets and the effect of sewage disposal.
5. Examinations and inspections of the Neponset, Aberjona, Assabet and Charles rivers, and the enforcement of special laws relative to the protection of the public health in the valleys of those rivers.

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[1] A report of the doings of the Department under the general laws relating to the protection of inland waters, and under the numerous other general and special laws pertaining to that subject, as presented to the Legislature, will be found on pages 273 to 337 and pages 375 to 434.

6. Engineering work upon the improvement of the channels of the Neponset River and its tributaries.

7. The determination of areas in which shellfish are polluted, the drainage of wet lands for the protection of the public health, and such other work as may be directed by various legislative acts.

A brief review of the work during the year 1916 follows: —

1. ADVICE TO CITIES, TOWNS AND PERSONS RELATIVE TO WATER SUPPLY, DRAINAGE, SEWERAGE AND THE DISPOSAL OF MANUFACTURING WASTE.

The work of the Department relating to these subjects is carried out in part under the general law, which requires cities, towns and persons to submit their plans relative to water supply, drainage, sewerage and the disposal of manufacturing waste to the State Department of Health for its advice, and in part under a large number of special laws relating to cities, towns and districts, under the provisions of which the approval of the Department is required before the location or construction of works relating to water supply, drainage or sewerage can be begun.

During the year 1916 the total number of applications relating to the subjects of water supply, drainage, sewerage and the pollution of streams submitted for action by the Department was 154, of which 37 were in relation to public water supplies, 60 to wells and springs, 8 to sources of ice supply, 25 to sewerage, drainage and sewage disposal, 5 to the pollution of streams, and 19 to miscellaneous matters.

On account of the scarcity and high price of materials and labor, the amount of work done during the past year in the construction and extension of water supplies and sewerage systems has been less than for many years.

2. EXAMINATION OF WATER SUPPLIES.

Most important of all the influences affecting the public health of the cities and towns of the State is the condition of the public water supplies. About 96 per cent. of the inhabitants of Massachusetts live in cities and towns which are provided with public water supplies, and more than 300 independent sources of water supply were used during the past year in supplying water to this population, amounting to nearly 3,500,000 persons in 212 cities and towns.

The sources of water supply of the cities, towns and districts are in all cases under the control of water boards, commissions or boards of public works, and the work of this Division is carried on very largely in co-operation with the boards having charge of these works. Inspections of the various water supplies made during the past year have included an inspection of the surroundings of the various sources of supply and the watersheds tributary thereto, chemical analyses of the water of various sources, biological examinations, and such bacterial studies as this Division has found it practicable or desirable to make in connection with these examinations. At the same time, information is collected as to the rainfall of the State, the capacity and yield of the various sources of water supply, and in general the adequacy of the various works to provide for the requirements of the population supplied. This information, relating as it does to more than 300 different sources of supply of various kinds, furnishes an invaluable collection of material for the assistance of the Department in advising as to water supply and matters relating thereto.

During the past year nearly all of the sources of water supply have been inspected, and samples of water have been collected from each for analysis at such intervals as seemed necessary or desirable either to the Department or to the officials in charge of the works. In cases where changes seemed desirable in the conditions affecting a water supply, the matter has been taken up with the officials in charge, and changes have been made wherever deemed necessary. This system appears to be satisfactory to the great majority of the water-works officials, and it supplies information of great value for the use of the Department in relation to the water supplies. While every effort is made to reduce the cost of the work, and especially to avoid unnecessary analytical work, the demand is an insistent one, and the amount of this work seems likely to increase rather than to diminish in the future. In order to carry it on efficiently and in accordance with reasonable desires of the authorities of the municipalities interested, a greater amount of work is likely to be required in the future than it has been possible to give to this service during the past year, and larger appropriations are likely to be required.

3. Examination of Rivers and Other Inland Waters.

The condition of the water of the various rivers of the State is determined at the present time by means of chemical analyses of samples of water collected monthly in the six drier months of the year at stations established at various points on the different streams. In addition to these examinations an inspection of each of the streams is made yearly, and generally in each year two or more of the rivers are selected for special examination, and inspection is made of all sources of pollution and the character and amount of this pollution determined by measurement and analysis. In connection with these investigations measurements are made to determine the actual flow of some of the rivers especially during the drier portion of the year, and information as to the storage and use of water is collected which serves also as a guide in estimating the probable flow of other streams.

During the year 1916 a thorough examination was made of the Blackstone, Housatonic and Taunton rivers, the sources of pollution of these streams examined, and the amount and character of this pollution determined. Careful observations were also made by the Department of the flow of several rivers, and the records of observations made by other agencies have been supplied for the use of this Division, especially those made by the Metropolitan Water Board of the flow of the Sudbury and Nashua rivers and by the Essex Company at Lawrence of the flow of the Merrimack River. Observations of the flow of certain of the streams are also made by the United States Geological Survey, the results of which are furnished for the use of the Department. It is evidently desirable that more careful observations of the flow of various rivers, as well as more careful determinations of the condition of their waters, shall be made in the future, in view of the great expansion of manufacturing in the Commonwealth in recent years, and it will probably be necessary to provide further funds for carrying on this work, since the condition of the various lakes and rivers is most important in its relation to the health and industry of the State.

In carrying out the work of this Division during the past year the Department has already taken up the question of securing an improvement in the method of disposal of the sewage of the city of Worcester for the purpose of preventing the objectionable pollution of the Blackstone River, and has taken up the matter of securing the removal of the sewage of the city of Taunton from the Taunton River, and the removal of the sewage of the city of Leominster from the North Branch of the Nashua River. A great improvement has been effected during the past year in the condition of the Housatonic River by the material enlargement of the works for treating the sewage of the city of Pittsfield.

4. EXAMINATION OF SEWER OUTLETS AND THE EFFECT OF SEWAGE DISPOSAL.

Under the general laws the Department is required to examine annually all main outlets of sewers and drainage of cities and towns in the Commonwealth, and the effect of sewage disposal. Much of this work is done in connection with the examination of rivers, but the principal sewer outlets of the State are those discharging into the sea or tidal waters, these outlets including those of the city of Boston and of the north and south metropolitan sewerage districts, respectively, which dispose of the sewage of more than one-third of the population of the State. These outlets have been the subject of careful examination during the past year, and chemical and bacterial analyses of the water at these outlets and at various distances therefrom have been made from time to time to determine the area in which sewage can be detected and its effect upon the waters of the estuaries in which the outlets are located. A most serious nuisance is caused by the discharge of the sewage of the city of Lynn close to the shore of the harbor along the water front of that city, and seriously objectionable conditions are created over a wide area in the neighborhood of Moon Island by the discharge of the sewage of the city of Boston. A change is being made in the location of the outlet of the north metropolitan sewerage system at Deer Island which will undoubtedly remove the objectionable conditions brought about by the increasing quantitites of sewage discharged at this outlet in the immediate neighborhood of one of the lighthouses. Most excellent deep-sea outlets have recently been provided for the sewage of the city of New Bedford and the town of Manchester, respectively, and new works have been designed for a better disposal of the sewage of the city of Lynn.

The examination of sewer outlets has also included observations of the operation of the various sewage disposal works established and maintained by many of the cities and towns in the State. The largest of these works is found at the city of Worcester, where a large part of the sewage is treated by chemical precipitation and discharged subsequently into the Blackstone River, while a smaller portion is treated by intermittent filtration upon an area of sand filters aggregating 74 acres. The sewage of the city of Fitchburg is treated by means of Imhoff tanks and trickling filters, while the sewage of Brockton is treated chiefly by intermittent filtration, though a trickling filter is used in connection with the works. At most of the other cities and towns the method of treatment employed is intermittent sand filtration, usually in connection with some form of sedimentation or other preliminary treatment. The number of cities and towns maintaining such works during the past year has been 33.

Examinations of these works have been necessarily confined for the most part to chemical analyses of the sewage and of the various effluents, generally at intervals of once a month. More thorough examinations are desirable, however, to show with reasonable accuracy the work performed by the different systems, and while the information supplied by the examinations thus far made shows in a general way the efficiency of these works, much valuable information could be obtained by a more careful observation of their operation, especially of the efficiency of the various preliminary treatments. It is possible that a rearrangement of the method of examination of these works might aid in securing more valuable information relating to their operation, but, in view of the circumstances and the requirements of the existing laws, it is hardly likely that more satisfactory information can be obtained relating to these works without a considerably greater outlay for more thorough observations.

5. Examinations and Inspections of the Neponset, Aberjona, Assabet and Charles Rivers, and the Enforcement of Special Laws relative to the Protection of the Public Health in the Valleys of those Rivers.

The Department is given authority under special acts of the Legislature relating to the prevention of the pollution of these rivers to prohibit the discharge of sewage into these streams and to prevent the discharge therein of any other substance which may be injurious to the public health or may tend to create a nuisance. No prosecutions have been instituted during the year for the pollution of any of these streams. A number of cases of pollution was found in the Aberjona and Charles river valleys, but in most cases such pollution was discontinued upon notice from the Department to the person responsible therefor.

In connection with this work it was found that the Aberjona River was receiving at one time a great quantity of picric acid from a munition works in the valley, the effect of which was to destroy fish life in the stream and to impart to the stream a decided color. Complaint was made to the Department that there appeared to be danger of injury to the health of bathers along the river. The matter was carefully studied by the engineers and physicians of the Department staff, but in no instance was it found that the condition of the water had caused injury to bathers. The objections to the pollution of the stream in this way, however, were taken up with the manufacturers, who installed works for relieving the river of acid, and by the end of the year the stream had become alkaline, as shown by chemical test.

6. Improvement of the Channels of the Neponset River and its Tributaries.

The actual work of dredging the Neponset River and its tributaries has been carried as far as practicable with the funds available for the work. Appropriations were made during the past year for surveys of the meadows, to determine their ownership with a view to assessing betterments for the special benefits received by estates from this work, and an appropriation was also made to study the problem of regulating the height of water at the dam below the outlet of the meadows. This work was delayed considerably in starting on account of difficulties of various kinds, especially in securing suitable assistants for the work, but was organized and in process of being carried out at the end of the year. It is evident that the drainage already done in these meadows has effected an enormous improvement, and it is also evident that further work will be necessary before the full effect of this improvement can be secured, and especially before it will be practicable to recover a large part of the betterment effected from the estates benefited.

7. THE DETERMINATION OF AREAS IN WHICH SHELLFISH ARE POLLUTED, AND THE DRAINAGE OF WET LANDS FOR THE PROTECTION OF THE PUBLIC HEALTH, TOGETHER WITH OTHER WORK UNDER VARIOUS LEGISLATIVE ACTS.

A large amount of time has been given to the determination of areas in which shellfish are polluted in Boston Harbor, under the laws relating to the prevention of the taking of shellfish from contaminated waters.

A small amount of work has also been done in connection with the question of the drainage of wet lands, with special reference to securing an investigation of this question, which is one of the most important in its relation to the public health that has been submitted for the consideration of the Department for many years. This work is being carried on in connection with the Department of Agriculture, since an improvement of these wet lands for the protection of health may also be so carried out as to make practicable the use of these lands for agriculture to the great benefit of the State.

In addition to the foregoing, the work of the past year has included investigations relative to the disposal of sewage of the city of Lynn and an investigation as to the improvement of Hale's Brook, a tributary of the Concord River, which flows through a densely populated section of the city of Lowell.

Considerable work has also been done by the Department in investigating proposed sites for various hospitals and public institutions during the year.

Brief summaries of the work of this Division in relation to the examination of water supplies, water supply statistics, including rainfall and stream flow, and the examination of rivers and of sewage disposal works are appended hereto.

EXAMINATION OF WATER SUPPLIES.

During the year most of the sources of water supply in the State have been examined by members of the Engineering Division, and inspections have been made of the conditions affecting these water supplies. The usual analyses of the waters of the various sources of supply have also been made during the year, and samples have been collected at such intervals as seemed necessary in order to obtain the necessary information concerning the condition of the water, or as deemed desirable by the water works authorities having charge of the various sources of supply.

The sources of water supply of the 212 cities and towns of the State which are provided with public water supplies are largely of two classes, — one, surface-water supplies from reservoirs of large capacity in proportion to the size of their watersheds; and two, ground-water supplies taken from wells and springs. In the case of the former, long storage of the water before it reaches the consumer insures, with reasonable precautions, a water supply that is safe for drinking, and the ground-water supplies drawn from wells and springs are also easily protected from danger of pollution. Practically three-fourths of the cities and towns of the State are supplied either from large reservoirs or from ground-water sources, and others are supplied from a combination of both. About 17 per cent. of the towns obtain their water supplies from streams or reservoirs of limited storage capacity, chiefly from streams flowing from watersheds having a porous soil and hence a higher summer yield than the ordinary, or from the mountain streams of the western part of the State, draining for the most part uninhabited regions.

The number of filters in use for the purification of polluted waters for the water supply of cities and towns is extremely small, since the use of such waters has been avoided for many years. There are a few cases where filters are used for the removal of iron from ground-water supplies, the condition of which had become objectionable from that cause.

For the determination of the condition of ground-water supplies, and the efficiency of filters used therewith, a chemical examination is essential, bacterial analyses being as a rule of little or no import in connection with such sources. In the case of the larger surface sources, also, the chemical and microscopical examinations are of the greatest value in determining the condition of the water. Bacterial examinations are of importance in observing the condition of many of the water supplies, and are essential in the case of those derived from sources of uncertain purity or subject to frequent change. It is impracticable for the State to make a sufficient number of bacterial analyses to exercise bacterial control over the more than 300 sources of water supply of 212 cities and towns having public water supplies, but such control is not necessary, and with most of the ground-water and surface-water supplies in the State the bacterial analyses furnish merely negative results. Such control must usually be exercised by laboratories situated on the ground which can make examinations at much smaller expense, especially if it is important that they be made at frequent intervals. An effort has been made during the year to make a greater number of bacterial analyses than formerly, especially in cases where they furnish valuable information with reference to the condition of a water supply.

It is undoubtedly desirable that the results of the analyses made by the Department should be communicated at the earliest practicable time to the water works authorities throughout the State. During the past year, however, the facilities for carrying on work at the laboratories have been somewhat restricted, and the delivery of the results of analyses has, in consequence, in some cases been seriously delayed. It is, furthermore, recognized that many of the water departments desire the printing of the results of the examinations of their water supplies, especially the chemical analyses, in order that the comparative condition of their sources of supply from year to year may readily be determined and this condition compared with that of the sources of other cities and towns. It is hoped that in the future space will permit the presentation of a larger number of the results of examinations of the water supplies than has been practicable in recent years.

The following table shows the usual average results of chemical analyses of surface-water supplies during the year 1916: —

Averages of Chemical Analyses of Surface-water Sources for the Year 1916.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Hardness.
				Free.	Albuminoid.			
					Total.	Suspended.		
Metropolitan Water District.	Wachusett Reservoir, upper end,	.36	3.60	.0020	.0147	.0024	.25	1.0
	Wachusett Reservoir, lower end,	.17	3.25	.0023	.0128	.0019	.26	1.0
	Sudbury Reservoir,	.18	3.80	.0024	.0153	.0028	.34	1.3
	Framingham Reservoir No. 3,	.20	3.84	.0051	.0176	.0042	.34	1.3
	Hopkinton Reservoir,	.74	4.52	.0024	.0216	.0026	.41	1.3
	Ashland Reservoir,	.79	5.02	.0028	.0238	.0022	.37	1.3
	Framingham Reservoir No. 2,	.85	4.85	.0057	.0272	.0030	.42	1.2
	Lake Cochituate,	.23	6.67	.0060	.0236	.0054	.72	2.5
	Chestnut Hill Reservoir,	.18	3.88	.0027	.0148	.0029	.36	1.4
	Weston Reservoir,	.16	3.81	.0034	.0146	.0018	.32	1.3
	Spot Pond,	.06	4.00	.0023	.0151	.0027	.37	1.4
	Tap in State House,	.18	4.43	.0013	.0138	.0026	.36	1.4
	Tap in Revere,	.08	4.06	.0014	.0133	.0018	.37	1.4
	Tap in Quincy,	.16	4.06	.0006	.0113	.0015	.37	1.5
Abington,	Big Sandy Pond,	.08	3.65	.0018	.0142	.0023	.72	0.7
	Little Sandy Pond,	.02	3.62	.0070	.0134	.0043	1.38	0.5
Adams,	Dry Brook,	.17	5.77	.0011	.0081	.0010	.10	4.8
	Bassett Brook,	.00	3.70	.0005	.0026	.0004	.08	2.4
Amherst,	Amethyst Brook large reservoir,	.55	3.00	.0025	.0138	.0021	.13	0.5
	Amethyst Brook small reservoir,	.20	3.12	.0033	.0113	.0023	.15	0.6
	Lower Reservoir,	.40	3.50	.0024	.0118	.0017	.15	0.5
Andover,	Haggett's Pond,	.19	4.19	.0035	.0171	.0019	.37	1.5
Ashburnham,	Upper Naukeag Lake,	.09	2.23	.0004	.0080	.0013	.16	0.4
Ashfield,	Bear Swamp Brook,	.27	6.60	.0027	.0086	.0009	.08	2.6
Athol,	Phillipston Reservoir,	.56	3.95	.0115	.0378	.0131	.20	0.9
	Buckman Brook Reservoir,	.20	2.95	.0055	.0231	.0080	.14	0.7
	Inlet of Filter,	.36	3.89	.0053	.0240	.0068	.15	1.1
	Outlet of Filter,	.31	4.12	.0038	.0156	-	.15	1.0
Barre,	Reservoir,	.14	3.02	.0031	.0171	.0030	.18	0.9
Blandford,	Freeland Brook,	.10	3.42	.0003	.0040	.0003	.20	1.2
Brockton,	Silver Lake,	.09	3.09	.0037	.0148	.0030	.66	0.7
Cambridge,	Upper Hobbs Brook Reservoir,	.75	6.45	.0069	.0317	.0054	.50	2.3
	Lower Hobbs Brook Reservoir,	.18	5.92	.0054	.0248	.0036	.50	2.4

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Hardness.
					Albuminoid.			
				Free.	Total.	Suspended.		
Cambridge — *Con.*, .	Stony Brook Reservoir, . .	.43	6.36	.0038	.0242	.0036	.58	2.5
	Fresh Pond, ...	.40	7.25	.0101	.0297	.0082	.68	3.1
Cheshire, . .	Thunder Brook, ...	.02	4.42	.0009	.0038	.0014	.09	3.4
	Kitchen Brook, ...	.01	4.63	.0003	.0030	.0006	.08	3.1
Chester, . . .	Austin Brook and Horn Pond, .	.11	3.58	.0019	.0081	.0013	.15	1.3
Chicopee, . .	Morton Brook, ...	.05	3.82	.0017	.0052	.0014	.17	0.9
	Cooley Brook, ...	.46	3.95	.0043	.0125	.0021	.16	1.1
Colrain, . . .	McClellan Reservoir, . . .	.05	6.78	.0010	.0053	.0000	.15	3.9
Concord, . .	Nagog Pond, ...	.08	2.71	.0029	.0134	.0014	.35	0.7
Dalton, . . .	Egypt Brook Reservoir, . .	.20	3.13	.0022	.0095	.0015	.12	1.4
	Cady Brook, ...	.31	4.55	.0009	.0104	.0006	.11	2.1
Danvers, . .	Middleton Pond, ...	.66	5.96	.0030	.0233	.0023	.46	1.7
Deerfield (South), .	Roaring Brook, ...	.10	5.45	.0004	.0045	.0005	.12	3.4
Egremont (South),	Goodale Brook, ...	.00	3.73	.0004	.0021	.0001	.09	2.1
Fall River, . .	North Watuppa Lake, . .	.16	4.34	.0027	.0178	.0027	.66	1.1
Falmouth, . .	Long Pond, ...	.00	3.56	.0031	.0106	.0013	1.06	0.3
Fitchburg, . .	Meetinghouse Pond, . . .	.10	2.95	.0022	.0133	.0023	.18	0.9
	Scott Reservoir, ...	.12	2.47	.0060	.0174	.0047	.23	0.5
	Wachusett Lake, ...	.08	2.85	.0039	.0173	.0027	.20	0.7
	Falulah Brook, ...	.17	3.00	.0036	.0139	.0030	.20	0.4
Gardner, . .	Crystal Lake, ...	.10	4.51	.0030	.0137	.0019	.29	1.8
Gloucester, . .	Dike's Brook Reservoir, . .	.37	4.18	.0036	.0160	.0021	.91	0.3
	Wallace Reservoir, . . .	.52	4.41	.0024	.0192	.0046	1.02	0.4
	Haskell Brook Reservoir, . .	.33	4.35	.0036	.0150	.0031	.94	0.4
Great Barrington, .	East Mountain Reservoir, . .	.06	4.87	.0010	.0084	.0030	.11	2.9
	Green River, ...	.00	8.97	.0007	.0026	.0003	.12	7.0
Great Barrington (Housatonic).	Long Pond, ...	.00	7.85	.0032	.0148	.0038	.13	5.8
Greenfield, . .	Glen Brook Upper Reservoir, .	.03	6.77	.0031	.0075	.0019	.17	3.2
	Glen Brook Lower Reservoir, .	.02	5.92	.0030	.0087	.0037	.17	3.4
Hadley, . . .	Hart's Brook Reservoir, . .	.05	4.02	.0001	.0023	.0000	.17	2.0
Hatfield, . .	Running Gutter Brook Reservoir,	.08	4.38	.0016	.0043	.0006	.20	2.1
Haverhill, . .	Johnson's Pond, ...	.17	5.48	.0033	.0199	.0027	.50	2.2
	Crystal Lake, ...	.21	3.63	.0024	.0187	.0023	.36	1.2

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Hardness.
				Free.	Albuminoid. Total.	Albuminoid. Suspended.		
Haverhill — *Con.*, .	Kenoza Lake, ...	.22	5.12	.0050	.0204	.0032	.45	2.1
	Lake Saltonstall, . . .	.09	6.23	.0021	.0180	.0030	.64	2.9
	Lake Pentucket, . . .	.19	5.45	.0036	.0192	.0021	.46	2.1
	Millvale Reservoir, . . .	.65	6.98	.0047	.0241	.0037	.41	2.8
Hingham, . .	Accord Pond, ...	.24	3.97	.0025	.0154	.0025	.74	0.6
Hinsdale, . .	Reservoir, ...	.19	2.63	.0039	.0102	.0016	.09	0.6
Holden, . . .	Muschopauge Lake, . . .	.04	2.63	.0016	.0116	.0017	.32	1.0
Holyoke, . .	Whiting Street Reservoir, . .	.04	5.02	.0058	.0175	.0025	.21	2.7
	Fomer Reservoir, . . .	.30	4.18	.0018	.0133	.0018	.15	1.3
	Wright and Ashley Pond, . .	.11	5.46	.0051	.0163	.0034	.17	2.6
	High Service Reservoir, . .	.11	4.54	.0060	.0167	.0031	.16	1.7
	White Reservoir, . . .	.23	3.30	.0064	.0136	.0023	.12	1.3
Hudson, . .	Gates Pond, ...	.06	3.80	.0029	.0181	.0027	.26	1.4
	Fosgate Brook, ...	.52	8.74	.0024	.0197	.0041	.24	3.4
Huntington, . .	Cold Brook Reservoir, . .	.16	2.25	.0009	.0056	.0007	.12	1.2
Ipswich, . . .	Dow's Brook Reservoir, . .	.26	5.39	.0049	.0184	.0030	.89	2.0
Lawrence, . .	Merrimack River, filtered, .	.37	5.55	.0056	.0077	–	.39	1.6
Lee, . . .	Codding Brook Upper Reservoir,	.14	3.52	.0021	.0078	.0009	.10	1.8
	Codding Brook Lower Reservoir,	.10	3.90	.0013	.0065	.0003	.10	2.6
	Basin Pond Brook, . . .	.72	3.47	.0038	.0195	.0019	.08	1.2
Lenox, . . .	Reservoir, ...	.04	6.55	.0020	.0074	.0012	.08	5.0
Leominster, . .	Morse Reservoir, . . .	.25	2.97	.0062	.0214	.0052	.17	0.4
	Haynes Reservoir, . . .	.24	3.05	.0116	.0446	.0195	.16	0.3
	Fall Brook Reservoir, . .	.16	2.58	.0028	.0129	.0028	.19	0.5
Lincoln, . . .	Sandy Pond, ...	.05	4.24	.0056	.0165	.0041	.38	1.3
Longmeadow, .	Cooley Brook, ...	.08	5.09	.0054	.0041	.0010	.22	2.4
Lynn, . . .	Birch Reservoir, . . .	.27	5.52	.0067	.0219	.0040	.75	2.0
	Breed's Reservoir, . . .	.41	6.30	.0104	.0272	.0049	.80	2.2
	Walden Reservoir, . . .	.44	6.82	.0072	.0223	.0034	.81	2.4
	Hawkes Reservoir, . . .	.52	6.35	.0081	.0247	.0034	.81	2.5
	Saugus River, ...	.86	8.74	.0074	.0338	.0043	.94	3.8
Manchester, . .	Gravel Pond, ...	.21	4.54	.0042	.0158	.0021	.90	1.0
	Round Pond, ...	1.42	6.93	.0092	.0294	.0034	.88	1.3

Averages of Chemical Analyses of Surface-water Sources, etc. — Continued.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.			Chlorine.	Hardness.
				Free.	ALBUMINOID. Total.	ALBUMINOID. Suspended.		
Marlborough, . .	Lake Williams, ...	.24	5.31	.0051	.0217	.0020	.57	1.8
	Millham Brook Reservoir, . .	.66	5.44	.0054	.0247	.0042	.44	1.6
Maynard, . .	White Pond, ...	.10	2.95	.0011	.0127	.0022	.28	0.5
Milford, . . .	Charles River, filtered, . .	.23	5.57	.0007	.0062	–	.36	2.4
Montague, . .	Lake Pleasant, ...	.06	2.64	.0012	.0107	.0047	.15	0.9
Nantucket, . .	Wannacomet Pond, . . .	.08	7.00	.0046	.0141	.0039	2.29	1.4
New Bedford, .	Little Quittacas Pond, . .	.45	4.70	.0046	.0215	.0028	.57	1.0
	Great Quittacas Pond, . .	.59	4.24	.0038	.0244	.0031	.58	0.9
North Adams, .	Notch Brook Reservoir, . .	.05	6.79	.0008	.0039	.0008	.08	5.8
	Broad Brook, ...	.17	3.70	.0016	.0056	.0006	.08	1.8
	Beaman Reservoir, . . .	.03	7.01	.0018	.0081	.0013	.09	4.9
Northampton, .	Middle Reservoir, . . .	.25	3.96	.0016	.0127	.0030	.15	1.5
	Mountain Street Reservoir, .	.08	3.85	.0013	.0075	.0012	.13	1.8
	West Brook, ...	.10	3.99	.0006	.0055	.0008	.13	1.7
North Andover, .	Great Pond, ...	.21	5.52	.0023	.0190	.0018	.47	1.7
Northborough, .	Lower Reservoir, ...	.72	3.70	.0026	.0235	.0035	.29	1.0
Northbridge, . .	Cook Allen Reservoir, . .	.12	3.17	.0076	.0099	.0010	.21	0.7
North Brookfield, .	Doane Pond, ...	.46	3.40	.0077	.0319	.0071	.18	0.9
	North Pond, ...	.54	3.60	.0063	.0365	.0116	.18	0.8
Northfield, . .	Reservoir, ...	.41	3.20	.0008	.0092	.0010	.10	0.9
Norwood, . .	Buckmaster Pond, . . .	.21	4.80	.0183	.0248	.0071	.60	1.5
Orange, . . .	Reservoir, ...	.09	3.27	.0005	.0034	.0003	.13	0.9
Palmer, . . .	Lower Reservoir, ...	.37	3.50	.0068	.0139	.0026	.17	0.7
Peabody, . .	Spring Pond and Suntaug Lake,	.16	6.71	.0113	.0149	.0023	.88	2.4
Pittsfield, . .	Ashley Lake, ...	.23	3.31	.0034	.0148	.0021	.09	1.5
	Ashley Brook, ...	.19	6.05	.0035	.0096	.0010	.10	4.5
	Hathaway Brook, ...	.02	9.41	.0004	.0034	.0004	.13	7.5
	Mill Brook, ...	.49	4.67	.0024	.0130	.0008	.09	2.0
	Sacket Brook, ...	.09	7.29	.0008	.0040	.0003	.11	6.3
	Farnham Reservoir, . . .	.61	4.29	.0034	.0182	.0022	.07	1.4
Plymouth, . .	Little South Pond, ...	.00	2.45	.0030	.0220	.0029	.72	0.2
	Great South Pond, ...	.00	2.65	.0021	.0163	.0019	.70	0.2
Randolph, . .	Great Pond, ...	.52	4.92	.0019	.0192	.0017	.75	1.3

Averages of Chemical Analyses of Surface-water Sources, etc. — Concluded.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.			Chlorine.	Hardness.
					Albuminoid.			
				Free.	Total.	Suspended.		
Rockport,	Cape Pond,	.46	12.18	.0073	.0243	.0045	4.88	2.3
Russell,	Black Brook,	.16	3.25	.0006	.0067	.0007	.13	1.2
Salem,	Wenham Lake,	.37	7.46	.0103	.0237	.0050	1.03	2.6
	Longham Reservoir,	1.60	7.88	.0222	.0390	.0048	.98	1.9
Shelburne,	Fox Brook,	.05	4.40	.0002	.0040	.0004	.09	2.9
Southbridge,	Hatchet Brook Reservoir No. 3,	.27	3.17	.0033	.0171	.0025	.18	0.6
	Hatchet Brook Reservoir No. 4,	.28	3.32	.0038	.0208	.0041	.18	0.5
South Hadley,	Leaping Well Reservoir,	.08	3.30	.0079	.0154	.0064	.20	0.9
	Buttery Brook Reservoir,	.13	4.32	.0076	.0084	.0014	.32	1.1
Spencer,	Shaw Pond,	.06	2.07	.0011	.0156	.0017	.19	0.9
Springfield,	Westfield Little River, filtered,	.21	3.74	.0009	.0079	–	.13	1.1
Stockbridge,	Lake Averic,	.12	7.21	.0011	.0144	.0017	.10	5.2
Stoughton,	Muddy Pond Brook,	.17	3.79	.0005	.0063	.0009	.41	0.9
Taunton,	Assawompsett Pond,	.33	4.16	.0058	.0185	.0029	.57	0.8
	Elder's Pond,	.11	4.05	.0091	.0212	.0036	.59	0.9
Wakefield,	Crystal Lake,	.25	5.78	.0099	.0208	.0025	.86	2.0
Wareham (Onset),	Jonathan Pond,	.02	2.33	.0013	.0094	.0011	.67	0.4
Wayland,	Snake Brook Reservoir,	.63	4.20	.0032	.0204	.0032	.34	1.5
Westfield,	Montgomery Reservoir,	.50	3.31	.0062	.0182	.0036	.13	0.3
	Tekoa Reservoir,	.39	3.06	.0028	.0124	.0017	.12	0.3
	Tillotson Brook Reservoir,	.13	2.91	.0011	.0049	.0003	.14	0.4
West Springfield,	Darby Brook Reservoir,	.10	5.92	.0198	.0187	.0071	.30	2.6
	Bear Hole Brook, filtered,	.07	8.70	.0018	.0048	–	.20	4.6
Weymouth,	Great Pond,	.69	3.86	.0044	.0203	.0022	.55	0.8
Williamsburg,	Reservoir,	.16	3.63	.0026	.0102	.0028	.14	1.6
Winchester,	North Reservoir,	.04	3.82	.0026	.0153	.0027	.46	1.5
	South Reservoir,	.05	3.12	.0045	.0159	.0035	.42	1.4
	Middle Reservoir,	.15	3.39	.0042	.0237	.0061	.41	1.3
Worcester,	Bottomly Reservoir,	.29	5.30	.0038	.0190	.0033	.23	1.6
	Kent Reservoir,	.26	4.50	.0031	.0165	.0020	.23	1.4
	Leicester Reservoir,	.21	3.81	.0049	.0175	.0029	.23	1.2
	Mann Reservoir,	.22	4.47	.0027	.0161	.0016	.23	1.4
	Upper Holden Reservoir,	.18	2.69	.0009	.0081	.0009	.22	0.5
	Lower Holden Reservoir,	.12	2.71	.0021	.0107	.0015	.20	0.7

The following table contains the averages of the analyses of groundwater sources during the year 1916: —

Averages of Chemical Analyses of Ground-water Sources for the Year 1916.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.		Chlorine.	NITROGEN AS —		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Acton,	Tubular wells,	.00	9.10	.0003	.0013	.68	.1458	.0000	3.5	.006
Amesbury,	Tubular wells,	.13	16.13	.0023	.0034	.57	.0010	.0000	9.4	.140
Ashland,	Tubular wells,	.00	4.62	.0002	.0010	.38	.0012	.0000	1.1	.006
Attleboro,	Large well,	.04	4.78	.0003	.0041	.54	.0195	.0000	1.9	.005
Avon,	Wells,	.00	8.33	.0005	.0014	.85	.2600	.0001	2.7	.008
Ayer,	Large well,	.00	6.00	.0002	.0013	.50	.0370	.0000	2.4	.005
	Tubular wells,	.00	6.00	.0000	.0002	.22	.0050	.0000	2.1	.011
Barnstable,	Tubular wells,	.00	4.32	.0009	.0008	1.17	.0018	.0000	0.7	.004
Bedford,	Large well,	.00	5.08	.0003	.0022	.35	–	–	2.3	.010
Billerica,	Tubular wells,	.18	7.60	.0015	.0069	.47	–	–	2.3	.043
Braintree,	Filter-gallery,	.18	11.05	.0009	.0104	1.24	.2350	.0000	3.3	.014
Bridgewater,	Wells,	.04	5.99	.0014	.0016	.68	.0304	.0010	2.0	.051
Brookfield (East),	Tubular wells,	.00	2.73	.0003	.0011	.24	.0033	.0000	0.6	.006
Brookline,	Tubular wells and filter-gallery,	.24	10.13	.0066	.0078	.82	.0220	.0002	4.2	.065
Canton,	Springdale well,	.00	4.14	.0005	.0014	.42	.0034	.0000	1.1	.007
	Well near Henry's Spring,	.12	4.97	.0005	.0037	.54	.0202	.0000	1.5	.008
Chelmsford (North),	Tubular wells,	.08	5.26	.0091	.0071	.51	.0565	.0002	1.8	.008
Chelmsford (Center),	Tubular wells,	.00	7.30	.0003	.0009	.61	.0973	.0001	2.8	.007
Chicopee (Fairview),	Tubular wells,	.00	4.73	.0004	.0007	.19	.0420	.0000	1.2	.010
Cohasset,	Tubular wells No. 2,	.06	13.20	.0005	.0048	1.95	.1075	.0000	4.9	.006
	Filtered water,	.72	9.51	.0014	.0158	1.40	.0050	.0000	2.8	.060
Dedham,	Large well and tubular wells.	.04	10.15	.0010	.0049	1.08	.1083	.0001	4.1	.007
Deerfield (Fire District).	Wells,	.00	4.48	.0003	.0019	.14	–	–	2.4	.012
Douglas,	Tubular wells,	.01	5.14	.0004	.0011	.37	.0372	.0000	1.6	.047
Dracut (Water Supply District).	Tubular wells,	.00	9.00	.0005	.0008	.56	.0786	.0000	3.8	.007
Dracut (Collinsville).	Tubular wells,	.03	6.02	.0004	.0030	.36	–	–	2.5	.020
Dudley,	Tubular wells,	.00	3.60	.0002	.0014	.25	.0034	.0000	1.0	.005
Duxbury,	Tubular wells,	.00	4.16	.0003	.0007	.91	.0146	.0000	0.7	.005
Easthampton,	Tubular wells,	.00	7.35	.0003	.0006	.16	.0225	.0000	4.0	.005
Easton,	Well,	.00	4.47	.0002	.0013	.64	–	–	1.7	.005
Edgartown,	Large well,	.00	3.00	.0005	.0012	.97	–	–	0.4	.003

Averages of Chemical Analyses of Ground-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as —		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Fairhaven,	Tubular wells,	.35	8.10	.0016	.0088	1.09	.0790	.0000	2.5	.008
Foxborough,	Tubular wells,	.01	6.90	.0011	.0015	.48	.0470	.0000	2.3	.013
Framingham,	Filter-gallery,	.08	9.14	.0093	.0076	1.10	.0142	.0002	4.3	.009
Franklin,	Tubular wells,	.00	5.45	.0004	.0008	.60	.0364	.0000	1.9	.008
Grafton,	Filter-gallery,	.08	14.31	.0007	.0054	1.99	.2200	.0000	5.2	.012
Granville,	Well,	.01	4.27	.0001	.0011	.12	–	–	2.4	.006
Groton,	Large well,	.00	6.15	.0000	.0014	.24	–	–	2.8	.009
Groton (West Groton Water Supply District).	Tubular wells,	.00	4.64	.0006	.0014	.20	.0107	.0000	2.8	.005
Hingham,	Wells,	.64	6.89	.0019	.0160	.82	.0197	.0003	1.8	.014
Holliston,	Large well,	.44	4.32	.0016	.0170	.40	–	–	1.4	.041
Hopkinton,	Tubular wells,	.00	12.97	.0006	.0025	.99	.1900	.0000	4.9	.028
Kingston,	Tubular wells,	.00	4.92	.0003	.0009	.76	–	–	1.2	.014
Leicester (Cherry Valley and Rochdale Water Supply District).	Wells,	.14	5.68	.0059	.0075	.31	–	–	2.1	.008
Littleton,	Tubular wells,	.00	4.10	.0002	.0016	.23	–	–	1.7	.005
Lowell,	Boulevard wells (tubular),	.40	6.71	.0364	.0058	.37	–	–	2.6	.224
Manchester,	Wells,	.00	11.74	.0005	.0009	1.99	.1442	.0000	4.2	.014
Mansfield,	Large well,	.00	4.12	.0003	.0014	.45	.0430	.0000	1.5	.005
Marblehead,	Wells and brook, filtered,	.17	17.46	.0003	.0068	3.27	.0127	.0000	6.6	.013
Marion,	Tubular wells,	.00	4.68	.0001	.0011	.77	.0253	.0000	1.1	.006
Marshfield,	Well,	.00	15.50	.0012	.0016	4.42	.0940	.0004	3.2	.017
Mattapoisett,	Tubular wells,	.00	6.68	.0004	.0016	1.05	.0487	.0000	2.3	.006
Medfield,	Spring,	.00	4.33	.0001	.0047	.39	.0140	.0001	1.4	.003
Medway,	Tubular wells,	.00	8.44	.0001	.0011	.63	.0572	.0000	3.3	.018
Merrimac,	Tubular wells,	.00	5.70	.0003	.0010	.56	.0177	.0000	2.4	.011
Methuen,	Tubular wells,	.40	8.03	.0026	.0092	.48	.0110	.0000	3.0	.073
Middleborough,	Well,	.31	7.09	.0045	.0064	.69	.0330	.0001	2.4	.236
	Filtered water,	.05	6.21	.0003	.0040	.70	.0404	.0000	2.4	.014
Millbury,	Well,	.06	4.15	.0009	.0034	.34	–	–	1.7	.051
Millis,	Spring,	.00	9.57	.0003	.0008	.77	.1675	.0001	3.8	.005
Monson,	Large well,	.01	2.95	.0004	.0019	.18	–	–	0.9	.005
Natick,	Large well,	.00	9.92	.0005	.0020	.80	.0332	.0000	4.9	.004
Needham,	Well No. 1,	.00	7.05	.0004	.0021	.72	.0867	.0000	2.5	.005

Averages of Chemical Analyses of Ground-water Sources, etc. — Continued.

[Parts in 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.	Ammonia.		Chlorine.	Nitrogen as —		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Needham — *Con.*	Well No. 2,	.00	7.02	.0006	.0022	.76	.0830	.0000	2.6	.004
	Hicks Spring,	.07	7.10	.0003	.0025	.80	.1283	.0000	2.0	.005
Newburyport,	Wells and springs,	.05	7.16	.0026	.0072	.73	.0293	.0000	2.9	.017
Newton,	Tubular wells and filter-gallery.	.00	6.97	.0006	.0036	.53	.0437	.0000	2.6	.005
No. Attleborough,	Wells,	.00	5.54	.0006	.0013	.53	.0268	.0000	2.4	.008
Norton,	Tubular wells,	.00	4.66	.0000	.0009	.39	–	–	1.1	.006
Norwood,	Tubular wells,	.16	9.11	.0013	.0066	.63	.0387	.0001	4.1	.032
Oak Bluffs,	Springs,	.01	4.20	.0009	.0021	.95	.0117	.0000	0.8	.010
Oxford,	Tubular wells,	.00	4.95	.0004	.0010	.33	.0480	.0000	1.8	.004
Palmer (Bondsville),	Tubular wells,	.00	5.82	.0004	.0010	.22	.0176	.0000	1.9	.006
Pepperell,	Tubular wells,	.00	3.92	.0001	.0009	.19	–	–	1.2	.006
Plainville,	Tubular wells,	.01	4.90	.0004	.0012	.35	–	–	2.1	.014
Provincetown,	Tubular wells in Truro,	.00	11.44	.0001	.0008	4.47	–	–	2.4	.015
Reading,	Filter-gallery,	.85	10.86	.0225	.0163	1.73	.0060	.0000	2.8	.238
	Filtered water,	.37	18.52	.0012	.0112	1.71	.0122	.0005	10.0	.022
Salisbury,	Well,	.03	10.85	.0003	.0013	.60	.0030	.0000	4.5	.025
Scituate,	Tubular wells,	.00	15.93	.0005	.0021	3.37	.1967	.0000	5.0	.006
Sharon,	Well,	.00	11.95	.0000	.0009	1.46	.2540	.0001	5.1	.005
	Tubular wells,	.02	3.87	.0004	.0009	.45	.0256	.0000	1.7	.038
Sheffield,	Spring,	.00	3.43	.0000	.0007	.08	–	–	1.7	.004
Shirley,	Well,	.00	5.07	.0002	.0006	.60	.1508	.0000	1.6	.008
South Hadley (Fire District No. 2).	Large well,	.00	3.70	.0006	.0010	.16	.0405	.0000	1.1	.008
Tisbury,	Well,	.00	4.65	.0002	.0006	.96	.0023	.0000	0.5	.005
Uxbridge,	Tubular wells,	.00	5.42	.0004	.0016	.56	.0648	.0000	1.9	.004
Walpole,	Tubular wells,	.00	5.02	.0002	.0010	.45	.0356	.0000	1.7	.006
Waltham,	Old well,	.19	9.35	.0047	.0037	.85	.0225	.0001	4.2	.103
	New well,	.00	7.79	.0011	.0034	.65	.0147	.0000	3.6	.006
Ware,	Wells,	.00	6.52	.0001	.0012	.43	.1158	.0000	2.3	.005
Wareham (Fire District).	Tubular wells,	.00	3.70	.0002	.0009	.60	.0007	.0000	0.7	.010
Warren (West),	Large well,	.00	5.78	.0006	.0012	.16	.0082	.0000	1.9	.006
Webster,	Wells,	.00	4.67	.0006	.0014	.37	.0184	.0000	1.8	.013
Wellesley,	Tubular wells,	.00	10.04	.0007	.0014	1.04	.0655	.0000	4.0	.015
	Well at Williams Spring,	.00	16.30	.0020	.0016	1.52	.6020	.0001	5.9	.007

Averages of Chemical Analyses of Ground-water Sources, etc. — Concluded.

[Parts in 100,000.]

CITY OR TOWN.	Source.	Color.	Residue on Evaporation.	AMMONIA.		Chlorine.	NITROGEN AS —		Hardness.	Iron.
				Free.	Albuminoid.		Nitrates.	Nitrites.		
Westborough, . .	Filter basin, ...	.01	3.22	.0016	.0089	.31	–	–	0.9	.012
West Brookfield, .	Tubular wells, ...	.00	4.61	.0003	.0009	.25	.0521	.0000	1.2	.004
Westford, . .	Tubular wells, ...	.00	3.90	.0002	.0007	.19	–	–	1.5	.006
Weston, . . .	Well, ...	.11	6.40	.0004	.0055	.63	.0420	.0000	3.0	.006
Winchendon, . .	Wells, ...	.09	3.68	.0016	.0027	.13	.0048	.0000	1.1	.088
Woburn, . .	Wells, ...	.00	12.08	.0022	.0040	1.56	.0371	.0000	5.6	.004
Worthington, . .	Springs, ...	.03	2.82	.0002	.0013	.10	–	–	0.9	.020
Wrentham, . .	Tubular wells, ...	.00	4.00	.0002	.0010	.40	.0558	.0000	1.4	.037

WATER SUPPLY STATISTICS, ALSO RECORDS OF RAINFALL AND FLOW OF STREAMS.

During the year 1916 a public water supply was introduced in the town of Cummington (population 660), the works having been practically completed at the end of the year 1915. The fact that there was practically no water works construction in 1916 was due chiefly to the high cost of such work and the difficulty of obtaining the necessary materials and labor. During the year the number of cities and towns in Massachusetts was increased by the establishment of the town of Millville from a part of the town of Blackstone, so that the State now contains 354 cities and towns. Of these, 212, including all of the 36 cities and 176 of the towns, are provided with public water supplies. The following table gives a classification by population of the cities and towns having and not having public water supplies at the end of the year: —

POPULATION (1915).	Number of Places of Given Population having Public Water Supplies.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having Public Water Supplies.	Total Population of Places in Preceding Column.
Under 500,	-	-	40	13,270
500-999,	7	5,229	36	27,536
1,000-1,499,	21	27,759	24	29,589
1,500-1,999,	12	21,685	20	33,947
2,000-2,499,	17	37,819	10	22,002
2,500-2,999,	20	54,895	6	16,013
3,000-3,499,	6	19,928	3	9,920
3,500-3,999,	8	30,123	-	-
Above 4,000,	121	3,329,981	3	13,614
Totals,	212	3,527,419	142	165,891

The 212 cities and towns having public water supplies are classified in the following table according to the dates when a fairly complete system of water supply was first introduced: —

Years.	Number of Public Water Supplies introduced.	Years.	Number of Public Water Supplies introduced.
Previous to 1850,	5	1890-1899, inclusive,	34
1850-1859, inclusive,	4	1900-1909, inclusive,	21
1860-1869, inclusive,	9	1910-1916, inclusive (seven years),	24
1870-1879, inclusive,	45	Total,	212
1880-1889, inclusive,	70		

The following table gives certain statistics relative to the number and the total population of the cities and towns supplied with water, and the character of the sources from which water is supplied: —

Water supplied from —	Number of Cities and Towns supplied.	Per Cent. of Cities and Towns supplied.	Population (1915).	Per Cent. of Total Population of All Cities and Towns supplied.
Lakes, ponds and storage reservoirs of large capacity in proportion to the yield of their watersheds.	72	34	2,402,728	68
Small streams or reservoirs of limited storage capacity.	35	17	222,612	6
River waters, filtered,	5	2	209,507	6
Springs, wells and other ground-water sources,	74	35	521,824	15
Ground-water sources in part and surface-water sources in part.	18	8	107,261	3
Ground-water sources supplemented with surface water filtered into ground sources.	8	4	63,487	2
Total,	212	100	3,527,419	100

The first table presented shows that although but 60 per cent. of the cities and towns in the State are provided with public water supplies, the total population of the places supplied is 96 per cent. of the total population of the State. The populations given in this table were obtained by using the total population of the cities and towns supplied, and are somewhat greater than the actual number of persons to whom the public water supply is available, but the difference is not great. With the exception of the town of Tewksbury, all of the towns in the State having a population in excess of 5,000 are now supplied with water, and there are only 12 towns having a population in excess of 2,500 which are not provided with public water supplies. These towns are as follows: —

Town.	Population.	Town.	Population.
Tewksbury,	5,265	Sutton,	2,829
Warren,	4,268	Seekonk,	2,767
Templeton,	4,081	Bourne,	2,672
Somerset,	3,377	Hanover,	2,666
Auburn,	3,281	Swansea,	2,558
Westport,	3,262	Wilbraham,	2,521

At the present time the water works are owned either by the municipality or by a water, water supply or fire district in all of the cities and 133 of the towns, while in 43 towns the works are owned by private companies. The following table gives the classification by population of the cities and towns which own their water works and those which are supplied with water by private companies: —

Population in 1915.	Cities and Towns owning Water Works.		Cities and Towns supplied with Water by Private Companies.	
	Number.	Total Population.	Number.	Total Population.
Under 1,000,	3	1,901	4	3,328
1,000–1,999,	23	33,846	10	15,598
2,000–2,999,	28	69,407	9	23,307
3,000–3,999,	8	28,942	6	21,109
4,000–4,999,	7	31,251	2	9,476
5,000–5,999,	16	88,166	3	16,117
6,000–6,999,	10	66,316	3	18,778
7,000–7,999,	7	52,937	–	–
Over 8,000,	67	2,979,893	6	67,047
Total,	169	3,352,659	43	174,760

The tendency toward municipal ownership of water works is shown in the following table, giving, for the census years since 1890, the total population of all cities and towns supplied with water, and the total population of those supplied by private companies with its percentage of the total population of all places supplied: —

YEAR.	Total Population of All Cities and Towns provided with Public Water Supplies.	Population of Towns supplied by Private Companies.	Per Cent. of Total Population supplied with Water.
1890,	1,924,812	318,319	16.5
1895,	2,237,017	212,579	9.5
1900,	2,565,301	236,869	9.2
1905,	2,792,490	193,290	6.9
1910,	3,171,055	159,730	5.0
1915,	3,528,769	174,760	5.0

The foregoing table shows that the total population of the towns supplied with water by private companies is only 5 per cent. of the total population of all of the cities and towns supplied with water, and there are only 12 towns having a population in excess of 5,000 which are supplied by private companies. These towns are as follows: —

TOWN.	Population (1915).	TOWN.	Population (1915).
Southbridge,	14,217	Fairhaven,	6,277
Milford,	13,684	Ludlow,	6,251
Dedham,	11,043	Grafton,	6,250
Palmer,	9,468	Amherst,	5,558
Bridgewater,	9,381	Millbury,	5,295
Northbridge,	9,254	Hingham,	5,264

In the annual report of the State Department of Health for the year 1915 (pages 296 to 306) there was presented a table showing the population and valuation of all of the cities and towns in Massachusetts in 1915, together with certain other information relative to the ownership of the water works and the date of their introduction into those places so provided.

CONSUMPTION OF WATER.

Records of the consumption of water are kept in nearly all of the cities and towns where water is pumped; and in several places supplied by gravity Venturi meters have been installed to measure the quantity supplied.

The following table gives statistics with regard to the consumption of water in the year 1916 in those cities and towns from which records could be obtained. The populations given in the table were obtained by adding one-fifth of the increase in population between 1910 and 1915 to the population as determined by the census of the latter year. The daily consumption of water per inhabitant has been obtained by dividing the average daily consumption by the estimated total population of the city or town in 1916. The quantity obtained in this manner is somewhat less than the actual consumption per person using the water, because there are in all cities and towns a greater or less number of persons who do not use the public supply. The difference between the number of inhabitants and the number of consumers would account, to a large extent, for the low rate per inhabitant in some of the towns which contain villages to which the public water supply has not been extended, and in towns where the works have been in operation but a short time and where, in consequence, water has not come into general use. In some towns the population during the summer months is much greater than is shown by the census returns, and in such cases the consumption per inhabitant as given in the table is higher than it would be if allowance were made for the increased population in the summer. With a few exceptions, however, the difference between the census returns and the actual population supplied is not great.

Consumption of Water in Various Cities and Towns in 1916.

City or Town.	Estimated Population.	Average Daily Consumption.		City or Town.	Estimated Population.	Average Daily Consumption.	
		Gallons.	Gallons per Inhabitant.			Gallons.	Gallons per Inhabitant.
Metropolitan Water District:[1] —	1,227,509	109,437,000	89	Metropolitan Water District — *Con.*			
Arlington,	15,629	929,000	59	REVERE,	26,570	1,591,000	60
Belmont,	8,589	448,000	52	SOMERVILLE,	88,778	6,184,000	70
BOSTON,	757,308	80,359,000	106	Stoneham,	7,569	438,000	58
CHELSEA,	45,621	3,071,000	67	Swampscott,	7,573	445,000	59
EVERETT,	38,565	2,891,000	75	Watertown,	17,243	1,126,000	65
Lexington,	5,662	389,000	69	Winthrop,	13,283	708,000	53
MALDEN,	49,808	2,460,000	49	Abington and Rockland.	12,787	580,000	45
MEDFORD,	31,981	1,487,000	46	Acton,	2,154	56,000	26
MELROSE,	17,113	782,000	46	Agawam,	4,766	98,000	21
Milton,	8,735	371,000	42	Amesbury,	8,273	582,000	70
Nahant,	1,428	159,000	111	Andover,	8,113	604,000	75
QUINCY,	42,280	2,499,000	59	Ashland,	2,070	33,000	16

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[1] Including Newton, which is within the District, but supplied from independent works.

Consumption of Water in Various Cities and Towns in 1916 — Continued.

CITY OR TOWN.	Estimated Population.	AVERAGE DAILY CONSUMPTION.	
		Gallons.	Gallons per Inhabitant.
Athol,	10,032	940,000	94
ATTLEBORO,	18,933	969,000	51
Avon,	2,194	79,000	36
Ayer,	2,775	173,000	62
Barnstable,	5,059	112,000	22
Bedford,	1,392	31,000	22
BEVERLY,	23,821	1,619,000	68
Billerica,	3,337	305,000	91
Braintree,	9,598	625,000	65
Bridgewater,	9,720	216,000	22
BROCKTON,	63,370	2,508,000	40
Brookline,	34,630	2,838,000	82
CAMBRIDGE,	109,619	9,711,000	89
Canton,	5,788	301,000	52
Chelmsford,	5,216	106,000	20
Clinton,	13,215	589,000	45
Cohasset,	2,843	322,000	113
Concord,	6,733	462,000	69
Danvers and Middleton.	12,875	1,384,000	107
Dedham,	11,395	1,008,000	88
Dudley,	4,394	106,000	24
Duxbury,	1,968	47,000	24
Easthampton,	10,109	697,000	69
East Longmeadow,	2,016	22,000	11
Easton,	5,049	147,000	29
Edgartown,	1,293	77,000	60
Fairhaven,	6,508	282,000	43
FALL RIVER,	125,890	6,068,000	48
Falmouth,	4,072	355,000	87
FITCHBURG,	40,022	4,232,000	106
Foxborough,	3,733	193,000	52
Framingham,	16,442	865,000	53
Franklin,	6,600	339,000	51
Gardner,	16,711	760,000	45
GLOUCESTER,	24,494	1,370,000	56
Grafton,	6,359	150,000	24
Greenfield,	13,056	1,385,000	106
Groton,	2,369	113,000	48
Holliston,	2,803	81,000	29
HOLYOKE,	61,433	6,014,000	98
Hudson,	6,761	257,000	38
Ipswich,	6,371	331,000	52
Lancaster,	2,609	83,000	32
LAWRENCE,	91,132	3,548,000	39
Lincoln,	1,337	213,000	159
Littleton,	1,228	36,000	29
Longmeadow,	1,922	80,000	42
LOWELL,	108,315	6,096,000	56
Ludlow,	6,512	211,000	32
LYNN and Saugus,	107,758	7,065,000	66
Manchester,	2,999	431,000	144
Mansfield,	5,890	532,000	90
Marblehead,	7,660	528,000	69
Marion,	1,492	85,000	57
MARLBOROUGH,	15,384	624,000	41
Mattapoisett,	1,376	45,000	33
Maynard,	6,846	299,000	44
Medway,	2,876	94,000	33
Methuen,	14,519	774,000	53
Middleborough,	8,714	402,000	46
Milford and Hopedale.	16,568	735,000	44
Millbury,	5,406	206,000	38
Montague and Erving.	9,309	669,000	72
Nantucket,	3,207	202,000	63
Natick,	11,370	657,000	58
Needham,	6,845	413,000	60
NEW BEDFORD,	112,151	8,516,000	76
NEWBURYPORT,	15,383	1,096,000	71

Consumption of Water in Various Cities and Towns in 1916 — Concluded.

CITY OR TOWN.	Estimated Population.	AVERAGE DAILY CONSUMPTION.		CITY OR TOWN.	Estimated Population.	AVERAGE DAILY CONSUMPTION.	
		Gallons.	Gallons per Inhabitant.			Gallons.	Gallons per Inhabitant.
NEWTON,	43,774	3,099,000	71	Southbridge,	14,542	669,000	46
North Andover,	6,041	316,000	52	SPRINGFIELD,	106,280	11,260,000	106
North Attleborough,	9,365	348,000	37	Stoughton,	7,115	346,000	49
North Brookfield,	2,921	229,000	78	TAUNTON,	36,541	2,480,000	68
Norton,	2,596	91,000	35	Tisbury,	1,350	129,000	96
Norwood,	11,570	948,000	82	Wakefield,	13,056	619,000	47
Oak Bluffs,	1,277	164,000	128	Walpole,	5,610	741,000	132
Orange,	5,398	141,000	26	WALTHAM,	30,618	2,258,000	74
PEABODY,	19,206	2,622,000	137	Ware,	9,460	455,000	48
Pepperell,	2,816	164,000	58	Wareham,	5,391	146,000	27
PITTSFIELD,	41,104	6,060,000	147	Webster,	12,776	567,000	44
Plainville,	1,413	27,000	19	Wellesley,	6,644	498,000	75
Plymouth,	13,083	1,072,000	82	West Brookfield,	1,280	40,000	31
Provincetown,	4,280	189,000	44	Westfield,	18,884	1,974,000	105
Randolph and Holbrook.	7,795	401,000	51	Westford,	2,841	113,000	40
Reading,	7,002	244,000	35	Weston,	2,389	114,000	48
Rockport,	4,379	219,000	50	Weymouth,	14,184	918,000	65
SALEM,	45,000	4,495,000	100	Whitman,	7,566	196,000	26
Salisbury,	1,729	68,000	39	Winchendon,	5,954	228,000	38
Sharon,	2,500	127,000	51	WOBURN,	16,630	2,229,000	134
Shirley,	2,273	83,000	37	WORCESTER,	166,039	14,230,000	86
Shrewsbury,	2,964	36,000	12	Wrentham,	2,548	105,000	41

RAINFALL.

The normal yearly rainfall in Massachusetts as deduced from long-continued observations in various parts of the State is 44.60 inches. The average rainfall for the year 1916 in these places was 42.84 inches, a deficiency of 1.76 of an inch. The year was the thirteenth in succession in which the rainfall has been less than the normal, the accumulated deficiency at the end of the year being 49.89 inches, or 5.29 inches more than the total rainfall in a normal year. There was an excess of precipitation in the months of February, April, May, June and July, and a deficiency in the other seven months of the year.

The greatest excess in any month occurred in July, when the average rainfall was 6.31 inches, or 2.48 inches greater than the normal, and the greatest deficiency occurred in October, when the average rainfall was 1.63 inches, or 2.18 inches less than the normal.

The following table gives the normal rainfall in the State for each month as deduced from observations at various places for a long period of years, together with the average rainfall at those places for each month during the year 1916, and the departure from the normal: —

MONTH.	Normal Rainfall (Inches).	Rainfall in 1916 (Inches).	Excess or Deficiency in 1916 (Inches).	MONTH.	Normal Rainfall (Inches).	Rainfall in 1916 (Inches).	Excess or Deficiency in 1916 (Inches).
January, . .	3.74	1.61	—2.13	August, . .	4.22	2.08	—2.14
February, .	3.63	5.29	+1.66	September, .	3.42	3.10	—0.32
March, . .	3.90	3.53	—0.37	October, . .	3.81	1.63	—2.18
April, . .	3.60	4.20	+0.60	November, .	3.85	2.59	—1.26
May, . .	3.68	3.97	+0.29	December, .	3.69	3.12	—0.57
June, . .	3.23	5.41	+2.18	Total, .	44.60	42.84	—1.76
July, . .	3.83	6.31	+2.48				

While the average rainfall during the year 1916 was much less than the normal rainfall for a long period of years, its distribution throughout the year was such that the flow of streams in the first seven months was greater than the normal; but in August the flow fell to less than the normal, and so continued until the end of the year. The effect of the excessive rainfall and consequent high flow of streams in the early months of the year was to fill practically all of the ponds and reservoirs used as sources of water supply to overflowing, and the excessive rainfall in the months of June and July kept them practically full until the end of the latter month, so that, notwithstanding the deficiency in the rainfall in the last five months of the year, little or no inconvenience was experienced anywhere from lack of water.

FLOW OF STREAMS.

Sudbury River.

The average flow of the Sudbury River during the year 1916 was 904,000 gallons per day per square mile, or about 91 per cent. of the normal flow for the past forty-two years. The flow was in excess of the normal in the months of April, May, June and July, but less than the normal in the other eight months of the year. The greatest excess occurred in the month of April and the greatest deficiency in the month of March. The average flow for the driest six months, July to December, inclusive, was 186,000 gallons per day per square mile, or 49 per cent. of the normal flow for such period during the past forty-two years.

In order to show the relation between the flow of the Sudbury River during each month of the year 1916 and the normal flow of that stream as deduced from observations during forty-two years, from 1875 to 1916, inclusive, the following table has been prepared. The area of the watershed of the Sudbury River above the point of measurement is 75.2 square miles.

Table showing the Average Daily Flow of the Sudbury River for each Month in the Year 1916 in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

MONTH.	NORMAL FLOW.		ACTUAL FLOW IN 1916.		EXCESS OR DEFICIENCY.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.841	1.190	1.458	0.942	—0.383	—0.248
February,	2.592	1.676	2.098	1.356	—0.494	—0.320
March,	4.195	2.711	2.815	1.820	—1.380	—0.891
April,	3.096	2.001	4.699	3.037	+1.603	+1.036
May,	1.646	1.064	2.226	1.439	+0.580	+0.375
June,	0.750	0.485	1.853	1.198	+1.103	+0.713
July,	0.285	0.184	0.906	0.585	+0.621	+0.401
August,	0.377	0.244	0.121	0.078	—0.256	—0.166
September,	0.335	0.216	0.040	0.026	—0.295	—0.190
October,	0.636	0.411	—0.008	—0.005	—0.644	—0.416
November,	1.136	0.735	0.170	0.110	—0.966	—0.625
December,	1.483	0.959	0.487	0.315	—0.996	—0.644
Average for whole year,	1.525	0.986	1.398	0.904	—0.127	—0.082

In the annual report of the State Department of Health for the year 1915 (pages 312 to 318) tables were presented giving the record of the rainfall upon the Sudbury River watershed and the yield expressed in inches in depth upon the watershed (inches of rainfall collected) for each of the forty-one years from 1875 to 1915, inclusive.

The corresponding record for the year 1916, together with the average for the entire period of forty-two years, is given in the following table: —

Rainfall, in Inches, received and collected on the Sudbury River Watershed.

MONTH.	1916.			MEAN FOR FORTY-TWO YEARS, 1875-1916.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	1.53	1.680	109.8	4.07	2.122	52.1
February,	5.91	2.262	38.2	4.16	2.723	65.4
March,	4.16	3.245	78.1	4.35	4.836	111.2
April,	4.19	5.243	125.1	3.57	3.455	96.9
May,	3.43	2.567	74.9	3.28	1.898	57.8
June,	4.77	2.068	43.4	3.06	0.837	27.3
July,	5.17	1.044	20.2	3.69	0.328	8.9
August,	2.01	0.139	6.9	3.85	0.435	11.3
September,	1.80	0.044	2.5	3.29	0.373	11.4
October,	1.49	—0.009	—0.6	3.79	0.733	19.4
November,	2.28	0.189	8.3	3.73	1.268	34.0
December,	3.22	0.562	17.4	3.83	1.710	44.7
Totals and averages,	39.96	19.034	47.6	44.67	20.718	46.4

The following table gives the record of the yield of the Sudbury River watershed for each of the past forty-two years, the flow being expressed in gallons per day per square mile of watershed in order to render the table more convenient for use in estimating the probable yield of watersheds used as sources of water supply: —

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1875.	1876.	1877.	1878.	1879.	1880.
January,	103,000	643,000	658,000	1,810,000	700,000	1,121,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000
March,	1,604,000	4,435,000	4,813,000	3,507,000	2,330,000	1,374,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,168,000
May,	1,188,000	1,139,000	1,391,000	1,394,000	1,114,000	514,000
June,	870,000	222,000	597,000	506,000	413,000	176,000
July,	321,000	183,000	202,000	128,000	158,000	177,000
August,	396,000	405,000	121,000	475,000	395,000	119,000
September,	207,000	184,000	60,000	160,000	141,000	80,000
October,	646,000	234,000	632,000	516,000	71,000	101,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000
December,	584,000	454,000	1,289,000	3,177,000	462,000	175,000
Average for whole year,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000
Average for driest six months,	574,000	384,000	502,000	532,000	230,000	143,000

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[1] The area of the Sudbury River watershed used in making up these records included water surfaces amounting to about 2 per cent. of the whole area, from 1875 to 1878, inclusive, subsequently increasing by the construction of storage reservoirs to about 3 per cent. in 1879, to 3.5 per cent. in 1885, to 4 per cent. in 1894 and to 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

MONTH.	1881.	1882.	1883.	1884.	1885.	1886.
January,	415,000	1,241,000	335,000	995,000	1,235,000	1,461,000
February,	1,546,000	2,403,000	1,033,000	2,842,000	1,354,000	4,800,000
March,	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000	2,059,000
April,	1,546,000	867,000	1,350,000	2,853,000	1,815,000	1,947,000
May,	965,000	1,292,000	938,000	1,030,000	1,336,000	720,000
June,	1,338,000	529,000	300,000	417,000	426,000	203,000
July,	276,000	86,000	115,000	224,000	62,000	115,000
August,	148,000	55,000	78,000	257,000	240,000	94,000
September,	197,000	306,000	91,000	44,000	121,000	118,000
October,	186,000	299,000	186,000	83,000	336,000	146,000
November,	395,000	210,000	205,000	175,000	1,178,000	673,000
December,	775,000	314,000	193,000	925,000	1,174,000	1,020,000
Average for whole year,	979,000	862,000	533,000	1,129,000	901,000	1,087,000
Average for driest six months,	330,000	211,000	145,000	200,000	391,000	223,000

MONTH.	1887.	1888.	1889.	1890.	1891.	1892.
January,	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000
February,	2,829,000	1,951,000	1,195,000	1,529,000	3,486,000	943,000
March,	2,868,000	3,237,000	1,339,000	3,643,000	4,453,000	1,955,000
April,	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000
May,	1,009,000	1,632,000	880,000	1,366,000	582,000	1,259,000
June,	414,000	422,000	653,000	568,000	414,000	428,000
July,	114,000	117,000	633,000	108,000	149,000	214,000
August,	214,000	380,000	1,432,000	132,000	163,000	280,000
September,	111,000	1,155,000	824,000	458,000	203,000	229,000
October,	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000
November,	368,000	2,758,000	1,941,000	1,215,000	305,000	697,000
December,	643,000	3,043,000	2,241,000	997,000	544,000	485,000
Average for whole year,	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000
Average for driest six months,	234,000	953,000	944,000	747,000	239,000	327,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

MONTH.	1893.	1894.	1895.	1896.	1897.
January,	433,000	693,000	1,034,000	1,084,000	845,000
February,	1,542,000	991,000	541,000	2,676,000	1,067,000
March,	3,245,000	2,238,000	2,410,000	3,835,000	2,565,000
April,	2,125,000	1,640,000	2,515,000	1,494,000	1,515,000
May,	2,883,000	840,000	636,000	360,000	915,000
June,	440,000	419,000	174,000	399,000	962,000
July,	158,000	161,000	231,000	95,000	658,000
August,	181,000	209,000	229,000	57,000	591,000
September,	108,000	150,000	89,000	388,000	182,000
October,	221,000	374,000	1,379,000	592,000	94,000
November,	319,000	836,000	2,777,000	659,000	909,000
December,	797,000	716,000	1,782,000	657,000	1,584,000
Average for whole year,	1,037,000	770,000	1,152,000	1,019,000	991,000
Average for driest six months,	237,000	356,000	460,000	314,000	564,000

MONTH.	1898.	1899.	1900.	1901.	1902.
January,	1,638,000	2,288,000	794,000	437,000	1,763,000
February,	3,022,000	1,381,000	3,800,000	300,000	1,674,000
March,	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000
April,	1,829,000	2,521,000	1,350,000	4,204,000	1,885,000
May,	1,246,000	511,000	1,312,000	2,954,000	743,000
June,	530,000	66,000	316,000	753,000	303,000
July,	231,000	19,000	—18,000	306,000	66,000
August,	1,107,000	—35,000	—34,000	424,000	135,000
September,	369,000	94,000	65,000	305,000	178,000
October,	1,160,000	115,000	186,000	412,000	506,000
November,	1,986,000	304,000	663,000	474,000	444,000
December,	1,799,000	220,000	1,096,000	2,695,000	1,779,000
Average for whole year,	1,450,000	973,000	1,082,000	1,342,000	1,140,000
Average for driest six months,	777,000	93,000	194,000	445,000	271,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Continued.

MONTH.	1903.	1904.	1905.	1906.	1907.
January,	1,736,000	477,000	1,410,000	1,128,000	1,351,000
February,	2,279,000	882,000	330,000	1,041,000	624,000
March,	3,454,000	2,999,000	2,497,000	2,409,000	1,658,000
April,	2,261,000	3,294,000	1,643,000	1,949,000	1,607,000
May,	351,000	1,745,000	297,000	1,059,000	888,000
June,	1,987,000	419,000	467,000	707,000	761,000
July,	445,000	62,000	177,000	398,000	9,000
August,	307,000	170,000	114,000	180,000	—104,000
September,	130,000	397,000	1,246,000	19,000	541,000
October,	492,000	191,000	158,000	301,000	741,000
November,	363,000	289,000	279,000	483,000	1,998,000
December,	582,000	269,000	887,000	659,000	2,032,000
Average for whole year,	1,190,000	931,000	795,000	860,000	1,010,000
Average for driest six months,	388,000	228,000	403,000	341,000	471,000

MONTH.	1908.	1909.	1910.	1911.	1912.
January,	1,925,000	392,000	1,490,000	519,000	728,000
February,	1,536,000	2,286,000	1,849,000	700,000	1,197,000
March,	2,257,000	1,734,000	1,954,000	1,144,000	3,092,000
April,	1,117,000	1,721,000	667,000	1,426,000	2,235,000
May,	1,046,000	1,004,000	277,000	318,000	1,447,000
June,	194,000	239,000	516,000	213,000	148,000
July,	—14,000	—121,000	—102,000	—14,000	—77,000
August,	102,000	—45,000	—73,000	20,000	—29,000
September,	—82,000	149,000	5,000	76,000	—28,000
October,	47,000	—51,000	—51,000	296,000	—14,000
November,	71,000	82,000	176,000	593,000	165,000
December,	136,000	263,000	221,000	908,000	494,000
Average for whole year,	694,000	625,000	570,000	514,000	779,000
Average for driest six months,	44,000	40,000	29,000	152,000	26,000

Yield of the Sudbury River Watershed in Gallons per Day per Square Mile — Concluded.

Month.	1913.	1914.	1915.	1916.	Mean for Forty-two Years, 1875-1916.
January,	1,041,000	908,000	1,629,000	942,000	1,190,000
February,	754,000	1,009,000	1,870,000	1,356,000	1,676,000
March,	2,090,000	3,029,000	593,000	1,820,000	2,711,000
April,	2,232,000	2,353,000	590,000	3,037,000	2,001,000
May,	867,000	1,550,000	255,000	1,439,000	1,064,000
June,	149,000	5,000	101,000	1,198,000	485,000
July,	—62,000	107,000	1,045,000	585,000	184,000
August,	—54,000	156,000	1,168,000	78,000	244,000
September,	88,000	—135,000	38,000	26,000	216,000
October,	484,000	—59,000	231,000	—5,000	411,000
November,	480,000	97,000	261,000	110,000	735,000
December,	732,000	250,000	898,000	315,000	959,000
Average for whole year,	733,000	772,000	719,000	904,000	986,000
Average for driest six months,	180,000	29,000	480,000	186,000	377,000

Note. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

Nashua River.

The average flow of the South Branch of the Nashua River above Clinton during the year 1916 was 1,215,000 gallons per day per square mile, or 13 per cent. in excess of the normal flow for the past twenty years. The flow was in excess of the normal in the months of January, February, April, May, June and July, but less than the normal in the other six months of the year. The greatest excess occurred in the month of June and the greatest deficiency in the month of December. The average flow for the driest six months, July to December, inclusive, was 432,000 gallons per day per square mile, or about 82 per cent. of the normal flow for such a period during the past twenty years.

In order to show the relation between the flow of the Nashua River during each month of the year 1916 and the normal flow of that stream as deduced from observations during twenty years, from 1897 to 1916, inclusive, the following table has been prepared. The area of the watershed of the Nashua River above the point of measurement was 119 square miles from 1897 to 1907, and 118.19 square miles from

1908 to 1913, inclusive. Since Jan. 1, 1914, the city of Worcester has been diverting water from 9.35 square miles of this watershed for the supply of that city, leaving the net watershed area 108.84 square miles. In the calculations of yield, allowance has been made for water overflowing from the Worcester area.

Table showing the Average Daily Flow of the South Branch of the Nashua River for each Month in the Year 1916, in Cubic Feet per Second per Square Mile of Drainage Area, and in Million Gallons per Day per Square Mile of Drainage Area; also, Departure from the Normal Flow.

MONTH.	NORMAL FLOW.		ACTUAL FLOW IN 1916.		EXCESS OR DEFICIENCY.	
	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.	Cubic Feet per Second per Square Mile.	Million Gallons per Day per Square Mile.
January,	1.913	1.237	2.035	1.315	+0.122	+0.078
February,	2.181	1.410	2.810	1.816	+0.629	+0.406
March,	3.948	2.552	2.926	1.891	−1.022	−0.661
April,	3.361	2.173	5.106	3.300	+1.745	+1.127
May,	1.852	1.197	2.626	1.697	+0.774	+0.500
June,	1.188	0.768	3.178	2.054	+1.990	+1.286
July,	0.687	0.444	1.680	1.086	+0.993	+0.642
August,	0.672	0.434	0.439	0.284	−0.233	−0.150
September,	0.506	0.327	0.454	0.294	−0.052	−0.033
October,	0.751	0.486	0.217	0.140	−0.534	−0.346
November,	1.131	0.731	0.496	0.321	−0.635	−0.410
December,	1.766	1.142	0.712	0.460	−1.054	−0.682
Average for whole year,	1.661	1.073	1.880	1.215	+0.219	+0.142

In the annual report of the State Department of Health for the year 1915 (pages 324 to 327) tables were presented giving the record of the rainfall upon the Nashua River watershed and the total yield expressed in inches in depth upon the watershed (inches of rainfall collected) for each of the nineteen years, from 1897 to 1915, inclusive. The corresponding record for the year 1916, together with the average for the entire period of twenty years, is given in the following table: —

Rainfall, in Inches, received and collected on the Nashua River Watershed.

MONTH.	1916.			MEAN FOR TWENTY YEARS, 1897-1916.		
	Rainfall.	Rainfall collected.	Per Cent. collected.	Rainfall.	Rainfall collected.	Per Cent. collected.
January,	1.60	2.346	146.7	3.67	2.206	60.1
February,	5.98	3.030	50.7	3.82	2.288	60.0
March,	3.32	3.374	101.5	4.11	4.553	110.7
April,	3.65	5.696	156.0	3.81	3.750	98.4
May,	3.34	3.028	90.7	3.36	2.136	63.6
June,	6.57	3.546	53.9	3.68	1.325	36.0
July,	5.66	1.937	34.2	4.24	0.792	18.7
August,	1.72	0.506	29.5	4.19	0.775	18.5
September,	4.21	0.506	12.0	3.53	0.565	16.0
October,	1.42	0.250	17.6	3.34	0.866	25.9
November,	3.15	0.554	17.6	3.38	1.262	37.4
December,	2.81	0.820	29.2	4.17	2.037	48.9
Totals and averages,	43.43	25.593	58.9	45.30	22.555	49.8

The following table gives a record of the yield of the Nashua River for each of the past twenty years, the flow being expressed in gallons per day per square mile of watershed: —

Yield of the Nashua River Watershed in Gallons per Day per Square Mile.[1]

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.
January,	796,000	1,563,000	2,092,000	796,000	519,000	1,676,000
February,	931,000	1,635,000	1,090,000	4,054,000	356,000	1,401,000
March,	2,760,000	3,088,000	2,776,000	3,722,000	2,718,000	3,992,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000
September,	380,000	676,000	250,000	127,000	320,000	241,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000
Average for whole year,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000
Average for driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6 per cent. in 1907, to 7 per cent. in 1908, 1909 and 1910, to 6.5 per cent. in 1911, to 6.8 per cent. in 1912, to 7 per cent. in 1913, to 7.4 per cent. in 1914 and 1915, and to 7.6 per cent. in 1916.

Yield of the Nashua River Watershed in Gallons per Day per Square Mile — Continued.

Month.	1903.	1904.	1905.	1906.	1907.
January,	1,265,000	659,000	1,266,000	1,132,000	1,458,000
February,	2,133,000	927,000	452,000	1,027,000	692,000
March,	3,423,000	3,008,000	3,004,000	1,860,000	1,697,000
April,	2,238,000	2,984,000	1,617,000	2,109,000	1,436,000
May,	569,000	1,498,000	445,000	1,533,000	965,000
June,	2,131,000	762,000	542,000	1,184,000	773,000
July,	624,000	497,000	365,000	728,000	335,000
August,	474,000	355,000	321,000	591,000	87,000
September,	375,000	494,000	1,228,000	277,000	810,000
October,	689,000	347,000	367,000	530,000	1,382,000
November,	634,000	343,000	442,000	749,000	2,540,000
December,	954,000	440,000	1,018,000	794,000	1,961,000
Average for whole year,	1,285,000	1,025,000	926,000	1,043,000	1,180,000
Average for driest six months,	626,000	413,000	541,000	613,000	725,000

Month.	1908.	1909.	1910.	1911.	1912.
January,	1,738,000	592,000	1,846,000	773,000	780,000
February,	1,736,000	2,556,000	1,845,000	625,000	927,000
March,	2,192,000	2,129,000	2,640,000	1,339,000	2,831,000
April,	1,269,000	2,422,000	1,034,000	1,393,000	2,281,000
May,	1,415,000	1,212,000	608,000	461,000	1,797,000
June,	403,000	632,000	824,000	351,000	331,000
July,	220,000	233,000	62,000	57,000	135,000
August,	443,000	193,000	186,000	188,000	125,000
September,	88,000	208,000	145,000	181,000	89,000
October,	158,000	90,000	68,000	718,000	145,000
November,	125,000	363,000	354,000	1,035,000	442,000
December,	387,000	537,000	391,000	1,067,000	793,000
Average for whole year,	847,000	918,000	828,000	682,000	891,000
Average for driest six months,	238,000	270,000	201,000	327,000	210,000

Yield of the Nashua River Watershed in Gallons per Day per Square Mile — Concluded.

MONTH.	1913.	1914.	1915.	1916.	Mean for Twenty Years, 1897-1916.
January,	1,414,000	990,000	2,062,000	1,315,000	1,237,000
February,	867,000	1,181,000	1,961,000	1,816,000	1,410,000
March,	2,263,000	3,137,000	572,000	1,891,000	2,552,000
April,	2,083,000	2,593,000	926,000	3,300,000	2,173,000
May,	1,038,000	1,699,000	455,000	1,697,000	1,197,000
June,	280,000	317,000	228,000	2,054,000	768,000
July,	19,000	329,000	1,083,000	1,086,000	444,000
August,	60,000	261,000	1,657,000	284,000	434,000
September,	219,000	—12,000	158,000	294,000	327,000
October,	678,000	136,000	387,000	140,000	486,000
November,	660,000	211,000	498,000	321,000	731,000
December,	955,000	372,000	1,359,000	460,000	1,142,000
Average for whole year,	879,000	934,000	942,000	1,215,000	1,073,000
Average for driest six months,	318,000	208,000	666,000	432,000	530,000

Merrimack River.

The flow of the Merrimack River has been measured for many years at Lawrence, above which place the river has a total watershed area of 4,663 square miles, which includes 118[1] square miles on the South Branch of the Nashua River, 75 square miles on the Sudbury River and 18 square miles tributary to Lake Cochituate, or a combined area of 211[1] square miles from which water is drawn at the present time for the supply of the Metropolitan Water District. The flow as measured at Lawrence includes the water wasted from these three watersheds, which, in the wet months of the year, is very considerable, but which becomes very small in the dry months. Records of the quantity of water wasted have been kept by the Boston Water Board and by the Metropolitan Water and Sewerage Board, and these quantities have been deducted from the flow as measured at Lawrence. The area of the three watersheds has also been deducted from the watershed area above Lawrence, so that the net watershed area above that point was 4,567 square miles in 1880, 4,570 square miles in the years 1881 to 1897, inclusive, and 4,452 square miles since the latter year.

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[1] Including 9.35 square miles from which water is drawn for the supply of the city of Worcester.

The average flow of the Merrimack River during the year 1916 amounted to 1.768 cubic feet per second, or 1,143,000 gallons per day, per square mile of drainage area, or 19 per cent. in excess of the normal flow for the past thirty-seven years for which records are available. The flow was in excess of the normal in the months of January, February, April, May, June, July, August and September, and less than the normal in the other four months of the year.

In order to show the relation between the flow of this stream during each month of the year 1916 and the normal flow as deduced from observations during thirty-seven years, from 1880 to 1916, inclusive, the following table has been prepared: —

Table showing the Average Monthly Flow of the Merrimack River at Lawrence for the Year 1916, in Cubic Feet per Second per Square Mile of Drainage Area; also, Departure from the Normal Flow.

MONTH.	Normal Flow.	Actual Flow in 1916.	Excess or Deficiency.
January,	1.313	1.527	+0.214
February,	1.449	1.674	+0.225
March,	2.726	1.735	—0.991
April,	3.692	4.323	+0.631
May,	2.189	2.733	+0.544
June,	1.229	3.101	+1.872
July,	0.744	1.531	+0.787
August,	0.692	0.924	+0.232
September,	0.649	0.972	+0.323
October,	0.811	0.798	—0.013
November,	1.115	0.743	—0.372
December,	1.226	1.154	—0.072
Average for whole year,	1.486	1.768	+0.282

The following table gives the record of the net flow of the Merrimack River at Lawrence for each of the past thirty-seven years, the flow being expressed in cubic feet per second per square mile of net drainage area: —

Flow of the Merrimack River at Lawrence in Cubic Feet per Second per Square Mile.

MONTH.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
January, ...	1.618	0.504	1.604	0.442	1.019	1.137	2.859	1.644	1.388	2.619
February, ...	2.687	1.027	2.016	0.634	2.054	0.938	3.798	2.823	1.818	1.345
March, ...	2.292	3.641	3.483	0.861	3.339	0.738	2.581	1.769	2.168	2.385
April, ...	2.358	3.511	2.268	3.382	5.656	3.967	4.931	4.788	5.377	2.408
May, ...	1.209	3.101	2.320	1.854	2.585	1.838	1.478	3.001	4.539	1.437
June, ...	0.696	1.094	1.963	1.100	0.893	0.917	0.714	1.786	1.228	1.164
July, ...	0.646	0.751	0.687	0.684	0.500	0.623	0.497	1.458	0.548	0.782
August, ...	0.554	0.611	0.470	0.423	0.461	1.191	0.435	1.866	0.577	1.087
September, ...	0.490	0.549	0.812	0.266	0.426	0.632	0.434	0.918	1.540	0.750
October, ...	0.388	0.545	0.678	0.432	0.400	0.749	0.471	0.682	2.656	1.220
November, ...	0.929	1.157	0.505	0.627	0.522	1.988	1.538	0.966	2.888	1.924
December, ...	0.580	1.832	0.472	0.515	1.022	1.496	1.296	1.337	3.181	2.812
Average for whole year,	1.204	1.527	1.440	0.935	1.573	1.351	1.753	1.920	2.326	1.661
Average for driest six months.	0.598	0.785	0.604	0.491	0.534	0.992	0.671	1.205	1.573	1.073

MONTH.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
January, ...	1.492	2.823	1.836	0.645	0.661	0.626	1.419	0.745	1.613	1.657
February, ...	1.656	2.851	0.925	1.081	0.933	0.507	1.941	1.000	1.638	1.032
March, ...	3.326	5.041	1.562	2.281	3.115	1.258	4.510	2.294	4.042	2.479
April, ...	3.728	4.645	1.774	3.359	2.401	4.289	3.967	3.839	3.316	5.757
May, ...	3.096	1.601	2.215	4.202	1.525	1.360	0.971	2.209	2.399	2.121
June, ...	1.716	0.990	1.272	0.963	1.317	0.664	0.769	2.769	1.416	0.667
July, ...	0.691	0.633	1.040	0.522	0.498	0.565	0.446	2.359	0.585	0.556
August, ...	0.745	0.538	1.051	0.564	0.370	0.477	0.441	1.105	0.776	0.467
September, ...	1.833	0.556	0.863	0.608	0.400	0.366	0.683	0.603	0.636	0.447
October, ...	2.648	0.467	0.467	0.790	0.493	0.863	1.134	0.482	1.372	0.401
November, ...	1.918	0.540	1.420	0.736	0.772	2.047	1.454	1.274	2.094	0.625
December, ...	1.418	0.899	0.859	1.166	0.661	2.025	0.952	2.262	1.871	0.622
Average for whole year,	2.022	1.799	1.274	1.410	1.095	1.254	1.557	1.745	1.813	1.403
Average for driest six months.	1.542	0.605	0.950	0.697	0.532	0.716	0.741	1.348	1.146	0.519

Flow of the Merrimack River at Lawrence in Cubic Feet per Second per Square Mile — Concluded.

MONTH.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.
January,	0.748	0.752	2.268	1.684	0.584	0.855	1.705	1.411	1.946	0.677
February,	3.520	0.546	1.196	1.979	0.644	0.503	1.133	0.667	1.648	1.563
March,	3.441	2.063	6.011	6.031	2.719	2.349	1.677	1.728	2.499	1.695
April,	4.087	5.568	3.801	3.375	4.494	3.615	3.591	2.923	2.652	3.404
May,	2.185	3.342	2.255	0.979	3.843	1.169	2.269	2.034	2.570	1.951
June,	0.878	1.656	1.187	2.224	1.016	0.931	2.262	1.190	0.932	0.948
July,	0.407	0.644	0.970	1.032	0.624	0.600	1.106	0.749	0.522	0.447
August,	0.420	0.989	0.844	0.734	0.573	0.606	0.741	0.431	0.668	0.376
September,	0.338	0.588	0.774	0.530	0.653	1.706	0.422	0.664	0.379	0.369
October,	0.564	0.913	1.600	0.826	0.816	0.727	0.549	1.433	0.330	0.422
November,	1.304	0.654	1.285	0.665	0.604	0.760	0.707	2.914	0.354	0.388
December,	1.486	2.054	1.755	0.825	0.407	1.274	0.566	2.177	0.420	0.504
Average for whole year,	1.615	1.647	1.995	1.740	1.415	1.258	1.394	1.527	1.243	1.062
Average for driest six months.	0.652	0.907	1.110	0.769	0.613	0.888	0.682	1.083	0.445	0.418

MONTH.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	Mean for Thirty-seven Years, 1880-1916.
January,	1.043	0.624	0.802	1.775	0.734	1.080	1.527	1.313
February,	0.973	0.482	0.706	0.987	0.958	1.742	1.674	1.449
March,	3.611	1.248	2.773	3.372	3.245	1.485	1.735	2.726
April,	2.445	3.045	4.323	2.490	4.954	1.788	4.323	3.692
May,	1.509	1.360	2.297	1.442	2.880	1.126	2.733	2.189
June,	1.077	0.551	1.304	0.899	0.737	0.489	3.101	1.229
July,	0.398	0.266	0.412	0.393	0.559	1.810	1.531	0.744
August,	0.458	0.328	0.499	0.306	0.434	2.064	0.924	0.692
September,	0.397	0.435	0.485	0.387	0.445	0.655	0.972	0.649
October,	0.300	0.918	0.733	0.791	0.303	0.657	0.798	0.811
November,	0.457	1.049	1.239	0.967	0.356	0.874	0.743	1.115
December,	0.335	1.284	1.069	1.046	0.437	1.303	1.154	1.226
Average for whole year,	1.084	0.966	1.387	1.238	1.337	1.256	1.768	1.486
Average for driest six months,	0.391	0.591	0.739	0.624	0.422	1.092	1.020	0.873

Sudbury, Nashua and Merrimack Rivers.

The following table shows the weekly fluctuation during the year 1916 in the flow of the three streams just described, namely, the Sudbury River at Framingham, the South Branch of the Nashua River above Clinton, and the Merrimack River at Lawrence. The flow of these streams, particularly that of the Sudbury and of the South Branch of the Nashua River, serves to indicate the flow of other streams in eastern Massachusetts. The area of the Sudbury River watershed is 75.2 square miles and of the South Branch of the Nashua River 118.19 square miles. The net watershed area of the Merrimack River is 4,452 square miles.

Table showing the Average Weekly Flow of the Sudbury, South Branch of the Nashua and Merrimack Rivers for the Year 1916 in Cubic Feet per Second per Square Mile of Drainage Area.

Week ending Sunday —	Flow in Cubic Feet per Second per Square Mile.			Week ending Sunday —	Flow in Cubic Feet per Second per Square Mile.		
	Sudbury River.	South Branch Nashua River.	Merrimack River.		Sudbury River.	South Branch Nashua River.	Merrimack River.
Jan. 2,	2.020	3.295	2.553	July 2,	0.622	1.440	2.191
9,	1.626	1.828	1.520	9,	1.063	1.383	2.130
16,	1.164	1.488	1.228	16,	0.717	0.925	1.341
23,	0.627	1.920	1.096	23,	0.178	2.296	0.961
30,	2.404	2.883	2.125	30,	1.798	2.316	1.655
Feb. 6,	0.665	2.017	2.022	Aug. 6,	—0.006	0.585	1.116
13,	1.651	1.629	1.247	13,	0.442	0.651	0.969
20,	1.560	1.195	1.085	20,	—0.184	0.256	0.785
27,	3.797	5.749	1.660	27,	—0.030	0.361	0.843
Mar. 5,	3.006	3.377	2.988	Sept. 3,	0.102	0.195	0.925
12,	1.752	2.100	1.328	10,	0.756	0.293	0.684
19,	1.137	1.896	1.111	17,	—0.087	0.995	1.001
26,	2.549	1.774	1.036	24,	0.052	0.393	1.279
Apr. 2,	7.080	8.524	4.351	Oct. 1,	—0.151	0.269	0.993
9,	6.627	5.369	4.976	8,	—0.054	0.147	0.903
16,	4.674	4.972	3.487	15,	0.057	—0.034	0.648
23,	3.161	3.866	3.539	22,	—0.020	0.526	0.792
30,	4.174	4.278	4.681	29,	0.151	0.249	0.836
May 7,	2.528	2.939	2.937	Nov. 5,	0.053	0.299	0.681
14,	1.438	1.582	1.905	12,	0.045	0.247	0.646
21,	3.646	4.689	3.869	19,	0.066	0.390	0.682
28,	1.599	1.806	2.639	26,	0.245	0.692	0.930
June 4,	1.283	1.595	1.718	Dec. 3,	0.451	0.873	1.331
11,	1.432	4.103	2.593	10,	0.310	0.556	1.339
18,	2.952	4.432	3.857	17,	0.567	0.742	0.966
25,	2.161	3.062	4.132	24,	0.592	0.942	0.889
				31,	0.467	0.623	1.093

EXAMINATION OF RIVERS.

One of the chief duties of the State Department of Health is the oversight and care of inland waters, including both those ponds and streams used as sources of water supply and also the rivers and the estuaries along the coast. The law provides that the Department may cause examinations of such waters to be made to ascertain their purity and fitness for domestic use, or their liability to impair the interests of the public or of persons lawfully using them or to imperil the public health. In carrying out these provisions of law in the matter of waters used as sources of water supply, the Department began many years ago the examination of various rivers and other inland waters of the State at points where the condition of these waters could be determined to best advantage, and has from time to time caused inspections, and in many cases careful studies, to be made of the condition of the more important streams and the circumstances affecting the purity of their waters. The cleaner streams require for the most part very little attention, and the work of the Department has been devoted chiefly to the observation of the condition of those rivers which are most seriously affected by the wastes of human life and industry, and the condition of which seems most likely to impair the interests of the public or of persons lawfully using them or to affect injuriously the public health.

In connection with these examinations an effort has been made to secure reliable observations of the flow of the different rivers, and this work has been carried on, when practicable, in co-operation with other departments and the national government. A result of the greater attention paid to this subject, both by the public departments and by private users of streams, has been the more careful observation of the yield of watersheds, and at the present time the flow of many of the rivers of the State is continually measured with care and accuracy.

The sewage of all the cities and towns of the State, together with all manufacturing waste, necessarily finds its way ultimately into the rivers or into the sea, either by direct discharge or after such treatment as is deemed necessary or practicable. Where an ample flow of water is available for dilution, the sewage can usually be discharged untreated into rivers or tidal estuaries at far less cost than by any other plan, and sometimes with little danger of nuisance or injury to the public health or to other public or private interest; but there is a great variation in the flow of streams in different seasons of the year, and there are also variations in flow caused by storage, topography and character of soil, as well as by variations in rainfall in different sections of the State, so that it is not practicable to consider the sewage-diluting capacity of the streams as proportionate to the size of their drainage areas. Furthermore, there are great variations in the flow of streams from year to year, and, while dilution in years of high rainfall may be ample for the disposal of a given quantity of sewage, objectionable conditions may be created in drier years by the discharge of an equal quantity. In the year 1916 the flow of streams was, as in previous years, quite abnormal. In the months of January, February and March, however, there was little variation from the normal flow. In April and May the flow was 50 per cent. in excess of the normal, and in June and July more than two and one-half times the normal, as indicated by the flow of the Nashua River. In the remaining months, from August to December, the flow was in each month much lower than in an average year. The flow in the month of June in the Nashua River watershed was higher than in that month in any of the twenty years since observations of the flow of that stream were begun, with the exception of June, 1903, while the flow in July was greater than in any other July since 1897. On the Sudbury River the flow for the month of June, 1916, was exceeded in that month only in the years 1881 and 1903, while the flow in July, 1916, was exceeded in that month only in the years 1889, 1897 and 1915.

The influence of the abnormally high flow of streams in the late spring and summer of the years 1915 and 1916 was to reduce materially during the warmer months of these years the effect of the pollution of streams by sewage and manufacturing waste, notwithstanding the great increase in manufacturing and probably, also, in population in the manufacturing cities and towns. A statement of the condition of each of the more important streams affected by sewage or manufacturing pollution will be found in a subsequent portion of this report. The results show in general continued deterioration in the condition of many of the more polluted streams, the condition of some of which, notably of the Blackstone, Neponset, Nashua, Hoosick and other streams, at certain points is highly objectionable.

The results of chemical examinations of the following rivers are presented herewith: —

Assabet.
Blackstone.
Charles.
Chicopee.
Concord.
Connecticut.
Deerfield.
French.
Green.
Hoosick.
Housatonic.
Merrimack.
Miller's.
Nashua.
Neponset.
Quaboag.
Quinebaug.
Sudbury.
Taunton.
Ten Mile.
Ware.
Westfield.

Blackstone River.

A thorough examination of this stream was made in 1916, and the results of this examination are presented in detail on pages 294 to 312.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River. — Averages for Six Months, from June to November, inclusive.

Blackstone River, below Cherry Valley.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908, . . .	-	20.57	3.83	.1531	.0624	.0508	.0116	5.76	.0020	.0007	-	-
1909, . . .	.35	13.93	3.34	.0681	.0470	.0334	.0136	3.70	.0125	.0003	.80	-
1910, . . .	.32	16.42	3.92	.0633	.0489	.0387	.0102	4.02	.0146	.0002	.85	-
1911, . . .	-	21.02	4.40	.1277	.0726	.0559	.0167	5.70	.0080	.0005	1.15	-
1912,[1] . . .	-	44.10	11.04	.2514	.2884	.1023	.1861	10.70	.0002	.0004	3.08	-
1913, . . .	-	32.32	6.52	.2591	.1628	.1122	.0506	8.18	.0015	.0004	2.06	-
1914, . . .	-	44.73	7.27	.3430	.1857	.1379	.0478	12.83	.0000	.0001	2.12	-
1915, . . .	-	19.23	5.15	.0985	.1142	.0785	.0357	3.08	-	-	1.89	-
1916, . . .	-	14.18	5.27	.0209	.0809	.0544	.0265	1.25	-	-	1.50	-

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[1] August omitted.

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER, ETC. — *Continued.*

Blackstone River, between Mill Brook Channel and the Sewage Precipitation Works of the City of Worcester.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1887,	0.91	–	–	.2686	.1741	–	–	1.35	.0160	–	–
1888,	0.76	–	–	.2658	.1112	.0557	.0555	1.50	.0382	.0041	–
1889,	0.86	–	–	.3980	.1430	.0772	.0658	1.32	.0177	.0026	–
1890,	1.14	9.92	3.03	.2107	.1246	.0673	.0573	1.07	.0250	.0015	2.9
1891,	1.10	17.42	5.59	.4913	.1950	.1127	.0823	2.29	.0192	.0037	5.0
1892,	0.52	20.75	6.30	.3547	.1433	.0708	.0725	2.43	.0227	.0108	6.1
1893,	0.40	16.98	4.55	.1480	.0588	.0240	.0348	1.01	.0115	.0015	6.3
1894,	0.66	16.93	4.76	.0548	.0380	.0236	.0144	0.74	.0115	.0005	4.4
1895,	0.49	14.17	4.50	.0613	.0414	.0243	.0171	0.92	.0163	.0006	3.4
1896,	0.51	12.90	2.93	.0780	.0415	.0282	.0133	0.97	.0147	.0015	3.4
1897,	0.85	26.45	7.68	.1130	.0674	.0362	.0312	0.89	.0090	.0024	4.2
1898,	0.33	17.42	5.62	.0857	.0619	.0260	.0359	0.96	.0053	.0010	4.6
1899,	0.14	34.38	10.60	.2583	.0788	.0390	.0398	–	–	.0004	14.3
1900,	0.05	16.48	3.38	.1068	.0518	.0210	.0308	1.03	.0107	.0012	3.6
1901,	0.23	31.03	11.68	.1410	.0548	.0309	.0239	–	–	.0023	13.8
1902,	0.10	46.15	12.47	.2453	.0728	.0274	.0454	–	–	.0010	16.5
1903,	0.18	24.06	6.80	.2836	.0750	.0472	.0278	–	–	.0027	8.4
1904,	0.12	44.68	17.08	.1228	.0434	.0225	.0209	–	–	.0008	14.7
1905,	0.21	50.36	19.49	.0952	.0492	.0203	.0289	–	–	.0003	29.3
1906,	0.11	40.07	15.25	.0688	.0421	.0189	.0232	–	.0032	.0002	20.3
1907,	0.04	44.07	17.67	.0613	.0343	.0180	.0163	–	–	.0003	–
1908,	0.16	23.67	5.55	.0990	.0291	.0153	.0138	3.23	.0134	.0014	–
1909,	–	52.97	18.55	.1865	.0381	.0239	.0142	4.80	.0033	.0010	–
1910,	0.15	50.92	18.97	.1933	.0545	.0309	.0236	4.07	.0023	.0009	–
1911,	0.11	44.64	15.70	.1920	.0449	.0212	.0237	4.03	.0170	.0009	–
1912,	0.10	40.05	10.91	.2047	.0352	.0225	.0127	3.58	.0027	.0011	–
1913,	0.10	35.17	10.34	.2767	.0491	.0285	.0206	3.18	.0003	.0008	–
1914,	0.14	35.03	8.23	.2993	.0771	.0510	.0261	3.85	.0012	.0018	–
1915,	0.13	39.00	11.68	.2383	.0650	.0392	.0258	2.96	–	–	–
1916,[1]	–	29.10	8.20	.2483	.0549	.0354	.0195	2.08	–	–	–

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[1] September omitted.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River, etc. — *Continued.*

Blackstone River, below Sewage Precipitation Works.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1890,	0.97	11.36	3.10	.2907	.1492	.0722	.0770	1.46	.0270	.0018	3.9
1891,	1.05	22.25	6.60	.6367	.1508	.0883	.0625	2.61	.0233	.0040	6.2
1892,	0.63	26.80	7.75	.5240	.1810	.0958	.0852	3.13	.0137	.0050	10.3
1893,	0.51	30.00	7.13	.5680	.1453	.0900	.0553	2.76	.0285	.0126	10.9
1894,	0.40	29.30	5.86	.6189	.1390	.1113	.0277	2.63	.0212	.0071	10.6
1895,	0.71	22.15	5.18	.3246	.0898	.0597	.0301	1.86	.0267	.0063	7.3
1896,	0.30	26.03	6.53	.2831	.0898	.0600	.0298	2.10	.0217	.0118	9.7
1897,	0.73	25.98	4.97	.3650	.1122	.0782	.0340	1.61	.0207	.0063	6.9
1898,	0.23	25.63	6.73	.3064	.0868	.0560	.0308	1.55	.0132	.0119	9.2
1899,	0.14	44.02	9.67	.5251	.1707	.0912	.0795	3.26	.0108	.0068	16.1
1900,	0.22	24.57	4.48	.4430	.1249	.0621	.0628	2.13	.0110	.0145	7.3
1901,	0.09	31.12	6.90	.4580	.1293	.0772	.0521	3.42	.0090	.0058	10.8
1902,	0.15	49.62	13.38	.7296	.1284	.0736	.0548	2.97	–	.0033	12.5
1903,	0.39	31.08	9.48	.3880	.1080	.0545	.0535	–	–	.0062	10.4
1904,	–	50.25	13.73	.6381	.1523	.0601	.0922	–	–	.0027	16.9
1905,	0.19	59.84	17.97	.4936	.0985	.0597	.0388	–	–	.0008	29.3
1906,	0.19	49.69	11.42	.6330	.1818	.0580	.1238	–	.0055	.0130	15.0
1908,	0.30	38.80	7.63	.9407	.1490	.0781	.0709	5.34	.0040	.0033	–
1909,	–	53.79	12.12	1.0567	.1282	.0792	.0490	6.92	.0067	.0075	–
1910,	–	52.15	12.52	1.0090	.1654	.0817	.0837	5.68	.0015	.0034	–
1911,	0.21	53.25	13.15	.9967	.1608	.0651	.0957	6.54	.0152	.0072	–
1912,	0.23	48.90	10.08	1.1700	.1673	.0904	.0769	6.12	.0137	.0096	–
1913,[1]	0.28	40.68	10.46	.9320	.1286	.0719	.0567	4.49	.0158	.0084	–
1914,	0.25	43.46	9.08	.8577	.1114	.0770	.0344	4.87	.0038	.0091	–
1915,	0.13	39.45	6.77	.6370	.1032	.0575	.0457	3.58	–	–	–
1916,[1]	–	49.21	9.00	.6684	.1031	.0607	.0424	3.69	–	–	–

[1] September omitted.

BLACKSTONE RIVER.

Chemical Examination of Water from Blackstone River, etc. — *Continued.*

Blackstone River, at Uxbridge.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.	
					Total.	Dissolved.	Suspended.				
1887,	.39	–	–	.1129	.0271	–	–	0.79	.0360	–	–
1888,	.38	6.42	1.52	.1155	.0288	.0222	.0066	0.68	.0310	.0007	–
1889,	.32	–	–	.1133	.0296	.0192	.0104	0.66	.0333	.0009	–
1890,	.26	8.86	2.12	.1629	.0231	.0174	.0057	0.79	.0259	.0005	2.9
1891,	.20	10.16	2.61	.2280	.0175	.0117	.0058	1.04	.0425	.0007	3.6
1892,	.13	9.36	1.88	.2840	.0227	.0162	.0065	0.99	.0313	.0007	3.1
1893,	.24	11.74	2.37	.1985	.0207	.0140	.0067	1.20	.0623	.0050	4.2
1894,	.35	13.07	2.03	.1456	.0243	.0183	.0060	1.57	.0673	.0050	4.9
1895,	.56	12.95	2.69	.0906	.0258	.0182	.0076	1.34	.0631	.0065	4.7
1896,	.33	12.68	2.67	.1129	.0257	.0221	.0036	1.38	.0477	.0091	5.0
1897,	.48	11.60	2.47	.1029	.0280	.0215	.0065	1.32	.0652	.0051	4.3
1898,	.49	10.59	2.78	.0801	.0264	.0219	.0045	1.00	.0470	.0076	3.8
1899,	.18	18.34	3.11	.2490	.0359	.0310	.0049	2.17	.0510	.0141	7.4
1900,	.19	13.42	2.04	.2260	.0347	.0257	.0090	1.76	.0558	.0060	5.0
1901,	.22	13.91	2.67	.3159	.0285	.0240	.0045	1.50	.0195	.0035	5.0
1902,	.15	14.17	2.56	.3462	.0270	.0218	.0052	1.95	.0210	.0018	4.9
1903,	.30	13.16	2.52	.3030	.0262	.0215	.0047	1.74	.0210	.0024	4.4
1904,	.20	13.78	2.74	.2399	.0282	.0214	.0068	2.12	.0408	.0022	4.6
1905,	.21	16.34	2.55	.3928	.0246	.0203	.0043	2.65	.0175	.0025	5.0
1906,	.19	14.73	3.10	.2218	.0242	.0200	.0042	2.10	.0252	.0009	4.2
1907,	.37	14.23	2.58	.2331	.0238	.0182	.0056	2.36	.0330	.0040	4.5
1908,	.31	16.33	4.07	.2387	.0253	.0196	.0057	3.05	.0408	.0071	–
1909,	.22	18.31	4.35	.3473	.0273	.0216	.0057	3.64	.0325	.0066	–
1910,	.26	22.53	4.69	.4963	.0356	.0302	.0054	4.62	.0498	.0043	–
1911,	.26	23.10	3.85	.3717	.0293	.0225	.0068	4.15	.0558	.0173	–
1912,	.21	21.91	3.06	.4897	.0345	.0288	.0057	4.06	.0497	.0137	6.5
1913,	.29	19.48	3.70	.3880	.0355	.0281	.0074	3.34	.0382	.0107	5.5
1914,	.25	23.72	2.84	.5285	.0355	.0284	.0071	4.55	.0482	.0154	7.2
1915,	.30	19.63	2.75	.3068	.0381	.0302	.0079	3.10	–	–	6.3
1916,[1]	.32	20.42	4.72	.3766	.0376	.0293	.0083	2.74	–	–	6.3

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[1] August omitted.

BLACKSTONE RIVER.

CHEMICAL EXAMINATION OF WATER FROM BLACKSTONE RIVER, ETC. — *Concluded.*

Blackstone River, at Millville.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Hardness.
					Albuminoid.						
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.	
1887, ...	.31	-	-	.0468	.0220	-	-	0.51	.0210	-	-
1888, ...	.41	5.22	1.40	.0467	.0296	.0233	.0063	0.50	.0278	.0004	-
1889, ...	.38	-	-	.0499	.0273	.0213	.0060	0.45	.0167	.0003	-
1890, ...	.26	6.71	2.24	.0736	.0196	.0152	.0044	0.53	.0229	.0003	2.3
1891, ...	.24	7.48	2.35	.1105	.0384	.0234	.0150	0.72	.0308	.0006	2.2
1892, ...	.37	6.70	1.62	.1143	.0294	.0210	.0084	0.63	.0217	.0002	2.0
1893, ...	.23	7.43	1.73	.0677	.0119	.0087	.0032	0.77	.0385	.0011	2.6
1894, ...	.47	8.42	2.16	.0510	.0172	.0139	.0033	0.89	.0273	.0012	2.8
1895, ...	.51	8.67	2.55	.0356	.0233	.0180	.0053	0.90	.0383	.0024	3.2
1896, ...	.35	8.53	1.69	.0484	.0237	.0180	.0057	0.97	.0413	.0027	3.3
1897, ...	.45	7.66	1.98	.0509	.0258	.0210	.0048	0.92	.0445	.0019	3.1
1898, ...	.51	7.12	2.17	.0325	.0240	.0193	.0047	0.63	.0240	.0023	2.5
1899, ...	.20	12.50	2.44	.1310	.0301	.0247	.0054	1.31	.0310	.0049	4.6
1900, ...	.29	9.33	1.82	.1168	.0254	.0219	.0035	1.15	.0417	.0039	3.4
1901, ...	.31	8.62	2.13	.1420	.0288	.0227	.0061	0.87	.0155	.0006	3.1
1902, ...	.28	9.43	2.24	.1623	.0284	.0238	.0046	1.20	.0195	.0010	2.8
1903, ...	.33	8.46	1.85	.1397	.0233	.0189	.0044	1.10	.0192	.0010	2.9
1904, ...	.29	8.71	2.06	.1079	.0235	.0201	.0034	1.26	.0337	.0009	2.9
1905, ...	.28	10.76	2.03	.1956	.0311	.0222	.0089	1.67	.0207	.0008	2.9
1906, ...	.37	9.02	2.15	.1526	.0306	.0251	.0055	1.27	.0188	.0006	2.4
1907, ...	.37	10.43	2.21	.1521	.0240	.0181	.0059	1.61	.0247	.0014	3.1
1908, ...	.33	9.85	2.53	.1295	.0232	.0185	.0047	1.78	.0258	.0024	3.4
1909, ...	.24	11.87	3.17	.1595	.0267	.0220	.0047	2.27	.0225	.0019	-
1910, ...	.30	13.94	3.32	.2350	.0277	.0234	.0043	3.01	.0290	.0013	-
1911, ...	.33	14.35	2.79	.1787	.0268	.0222	.0046	2.94	.0355	.0051	-
1912, ...	.29	15.20	2.18	.2433	.0283	.0249	.0034	2.91	.0421	.0064	-
1913, ...	.37	12.92	2.38	.1631	.0281	.0237	.0044	2.44	.0345	.0063	-
1914, ...	.28	14.33	2.78	.2245	.0304	.0243	.0061	2.78	.0233	.0065	-
1915, ...	.42	13.55	2.02	.1379	.0361	.0267	.0094	2.12		-	-
1916, ...	.38	13.31	2.78	.2284	.0266	.0199	.0067	1.86		-	-

CHARLES RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 286.

CHARLES RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHARLES RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Charles River, above Milford.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899,	.28	3.98	1.70	.0017	.0248	.0223	.0025	.27	.0027	.0003	.48	0.6
1900,	.49	3.93	1.67	.0017	.0251	.0231	.0020	.25	.0030	.0000	.64	0.5
1901,	.46	4.30	2.48	.0066	.0286	.0247	.0039	.25	.0060	.0002	.65	0.6
1902,	.58	4.42	1.90	.0025	.0248	.0210	.0038	.29	.0057	.0001	.70	1.1
1903,[1]	.56	4.17	1.86	.0015	.0203	.0171	.0032	.28	.0080	.0001	.68	0.8
1904,[2]	.49	3.95	1.83	.0117	.0267	.0209	.0058	.33	.0035	.0001	.62	1.1
1905,[3]	.55	3.77	1.62	.0020	.0229	.0201	.0028	.31	.0033	.0001	.56	0.8
1906,[3]	.62	4.05	1.90	.0032	.0257	.0230	.0027	.30	.0073	.0001	.68	0.6
1907,	.43	3.79	1.59	.0020	.0198	.0173	.0025	.32	.0047	.0001	.48	0.8
1908,	.36	3.11	1.43	.0023	.0198	.0171	.0027	.33	.0025	.0001	.42	0.5
1909,	.31	3.52	1.62	.0030	.0207	.0176	.0031	.32	.0012	.0000	.39	0.7
1910,	.37	3.47	1.34	.0042	.0231	.0204	.0027	.37	.0011	.0001	.46	0.8
1911,	.40	3.94	1.48	.0036	.0210	.0183	.0027	.42	.0007	.0000	.56	1.1
1912,	.38	3.62	1.29	.0037	.0226	.0182	.0044	.37	.0018	.0001	.45	1.0
1913,[3]	.47	4.40	1.50	.0060	.0245	.0222	.0023	.39	.0023	.0002	.49	0.9
1914,[3]	.34	4.03	1.43	.0046	.0228	.0178	.0050	.41	.0000	.0000	.35	0.9
1915,[3]	.75	5.00	2.27	.0039	.0296	.0260	.0036	.41	–	–	.84	1.1
1916,[3]	.49	4.70	2.23	.0058	.0219	.0207	.0012	.37	–	–	.75	1.0

[1] October omitted.

[2] Two months.

[3] Three months.

Charles River, below Milford.

1898,	.63	10.47	3.08	.1195	.0597	.0422	.0175	2.47	.0473	.0064	.69	2.4
1899,	.50	12.52	3.12	.3487	.1345	.0803	.0542	3.00	.0053	.0008	1.12	2.6
1900,	.56	12.85	2.65	.7123	.0764	.0563	.0201	2.74	.0140	.0055	.93	3.1
1901,	.63	9.52	3.37	.1419	.0451	.0317	.0134	1.40	.0422	.0048	.86	2.6
1902,	.52	10.74	3.38	.2118	.0658	.0406	.0252	2.21	.0236	.0049	1.02	2.7
1903,[1]	.49	9.03	2.85	.2237	.0479	.0277	.0202	1.36	.0396	.0050	.66	2.5
1904,[2]	.50	9.20	2.94	.2105	.0508	.0350	.0158	1.44	.0513	.0055	.63	2.6
1906,[3]	.68	8.76	2.90	.1536	.0568	.0427	.0141	1.64	.0160	.0012	.92	2.0
1907,	.54	12.95	2.83	.4607	.0864	.0525	.0339	2.94	.0352	.0021	.86	3.2
1908,	.48	10.81	3.48	.3925	.0598	.0347	.0251	1.79	.0218	.0049	.64	–
1909,	.50	12.66	4.07	.5658	.0479	.0399	.0080	1.89	.0273	.0064	.72	–
1910,	.57	15.21	3.83	.8038	.0640	.0499	.0141	3.01	.0248	.0082	.88	4.2
1911,	.58	14.12	3.64	.2881	.0447	.0323	.0124	2.51	.0785	.0114	.75	4.4
1912,	.47	15.99	3.24	.5413	.0480	.0370	.0110	2.67	.0880	.0101	.64	5.5
1913,	.58	13.58	3.65	.2918	.0536	.0361	.0175	1.94	.0505	.0108	.96	3.8
1914,	.48	12.47	2.87	.2817	.0470	.0368	.0102	1.74	.0298	.0085	.74	3.3
1915,	.72	12.00	3.58	.1327	.0587	.0344	.0243	1.61	–	–	1.04	3.1
1916,[4]	.41	12.26	4.96	.1258	.0251	.0220	.0031	1.93	–	–	.81	2.9

[1] November omitted.

[2] Four months.

[3] June omitted.

[4] October omitted.

CHARLES RIVER.

Chemical Examination of Water from Charles River, etc. — *Concluded.*

Charles River, opposite Pumping Station of Brookline Water Works.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887,	.83	5.37	1.62	.0013	.0282	–	–	.44	.0087	–	–	–
1888,	.98	4.87	1.92	.0014	.0264	.0240	.0024	.37	.0062	.0002	–	–
1895,	.74	4.91	2.08	.0004	.0237	.0207	.0030	.48	.0055	.0001	.75	1.5
1897,	1.02	5.36	2.45	.0012	.0288	.0262	.0026	.43	.0067	.0001	.86	1.5
1898,	.87	5.22	2.40	.0012	.0303	.0281	.0022	.39	.0035	.0001	.92	1.4
1899,	.46	5.03	1.92	.0011	.0262	.0230	.0032	.45	.0025	.0001	.62	1.5
1900,	.56	4.96	1.60	.0018	.0252	.0229	.0023	.46	.0020	.0000	.70	1.4
1901,	.92	5.45	2.60	.0020	.0314	.0275	.0039	.41	.0047	.0001	.95	1.4
1902,	.52	5.46	2.03	.0031	.0234	.0211	.0023	.57	.0045	.0001	.64	1.6
1903,	.71	6.22	2.30	.0031	.0240	.0223	.0017	.53	.0065	.0001	.80	1.5
1904,	.51	5.24	2.17	.0021	.0224	.0208	.0016	.55	.0060	.0001	.67	1.6
1905,[1]	.84	5.93	2.60	.0029	.0318	.0277	.0041	.54	.0056	.0002	.92	1.5
1906,[1]	1.05	6.00	2.77	.0039	.0294	.0267	.0027	.53	.0032	.0001	1.17	1.4
1907,[1]	.63	6.15	2.40	.0022	.0246	.0228	.0018	.64	.0026	.0001	.73	1.7
1908,[1]	.55	5.93	2.29	.0035	.0248	.0222	.0026	.65	.0036	.0002	.61	1.7
1909,[2]	.65	5.75	2.00	.0023	.0254	.0236	.0018	.69	.0015	.0001	.75	1.5
1910,	.60	6.71	2.79	.0028	.0289	.0260	.0029	.83	.0013	.0001	.72	1.8
1911,	.85	7.42	3.02	.0040	.0302	.0258	.0044	.80	.0032	.0001	1.10	2.0
1912,	.56	6.30	2.07	.0043	.0298	.0237	.0061	.85	.0012	.0001	.69	2.1
1913,	.74	7.32	2.27	.0053	.0342	.0300	.0042	.85	.0043	.0002	.86	2.0
1914,	.55	7.10	1.87	.0055	.0314	.0265	.0049	.92	.0032	.0001	.66	2.1
1916,[2]	.45	8.10	2.60	.0087	.0245	.0211	.0034	.96	–	–	.65	2.0

[1] Five months.

[2] Two months.

Charles River, opposite Pumping Station of Waltham Water Works.

1887,	.67	6.02	1.62	.0029	.0274	–	–	.48	.0043	–	–	–
1888,	.82	5.47	1.88	.0035	.0310	.0265	.0045	.41	.0087	.0002	–	–
1897,	.95	6.06	2.45	.0056	.0322	.0299	.0023	.53	.0073	.0002	.83	1.9
1898,	.81	5.74	2.46	.0050	.0329	.0296	.0033	.44	.0043	.0001	.85	1.6
1899,	.41	5.50	1.81	.0047	.0264	.0248	.0016	.51	.0051	.0002	.52	1.9
1900,	.52	5.93	1.68	.0064	.0282	.0259	.0023	.53	.0070	.0002	.58	1.7
1901,	.82	5.93	2.72	.0065	.0322	.0289	.0033	.44	.0067	.0002	.85	1.8
1902,	.45	6.21	1.97	.0084	.0258	.0228	.0030	.62	.0077	.0003	.59	2.0
1903,	.64	6.06	2.21	.0078	.0267	.0239	.0028	.58	.0084	.0003	.71	2.0
1904,	.55	6.08	2.22	.0062	.0317	.0266	.0051	.62	.0095	.0002	.62	2.0
1905,	.79	6.29	2.54	.0077	.0363	.0308	.0055	.58	.0075	.0002	.80	1.7
1906,	1.00	6.70	2.58	.0063	.0335	.0297	.0038	.59	.0038	.0002	.98	1.8
1907,[1]	.58	6.22	2.24	.0067	.0278	.0247	.0031	.63	.0058	.0002	.65	2.0
1908,	.62	6.50	2.49	.0048	.0344	.0284	.0060	.69	.0027	.0001	.64	1.9
1909,	.54	6.79	2.36	.0063	.0349	.0298	.0051	.76	.0026	.0002	.53	2.0
1910,	.59	7.37	2.87	.0078	.0336	.0299	.0037	.81	.0037	.0003	.56	2.4
1911,	.75	7.47	2.95	.0086	.0343	.0308	.0035	.85	.0030	.0003	.87	2.3
1912,	.57	7.59	2.32	.0095	.0320	.0280	.0040	.92	.0038	.0002	.63	2.6
1913,[2]	.68	7.68	2.54	.0083	.0437	.0378	.0059	.91	.0041	.0003	.74	2.3
1914,	.52	7.45	1.98	.0117	.0353	.0297	.0056	.92	.0030	.0002	.57	2.6
1915,	.93	8.30	2.97	.0131	.0475	.0407	.0068	.91	–	–	1.11	2.3
1916,	.69	8.68	3.38	.0163	.0328	.0246	.0082	.89	–	–	.91	2.2

[1] July omitted.

[2] June omitted.

Chicopee River.

A general statement of the condition of this river and its tributaries during the year 1916 will be found on page 287.

CHICOPEE RIVER.

Chemical Examination of Water from Chicopee River and its Tributaries. — Averages for Six Months, from June to November, inclusive.

Ware River, below Ware.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
					Total.	Dissolved.	Suspended.					
1898, . . .	.64	4.42	1.94	.0028	.0332	.0250	.0082	.19	.0025	.0003	.77	1.0
1899, . . .	.46	4.82	1.77	.0052	.0371	.0268	.0103	.25	.0015	.0004	.66	0.9
1900, . . .	.51	4.93	1.64	.0066	.0321	.0243	.0078	.25	.0030	.0003	.73	1.1
1901, . . .	.73	4.79	2.15	.0082	.0300	.0242	.0058	.18	.0044	.0002	.84	1.3
1902, . . .	.76	4.86	2.17	.0071	.0348	.0252	.0096	.23	.0040	.0003	.93	1.0
1903,[1] . . .	.68	4.83	2.18	.0072	.0345	.0240	.0105	.25	.0034	.0003	.78	0.8
1904,[1] . . .	.60	5.60	2.36	.0043	.0411	.0285	.0126	.29	.0046	.0004	.72	1.1
1908, . . .	.56	7.38	2.86	.0265	.0418	.0264	.0154	.37	.0033	.0005	.80	–
1909,[1] . . .	.61	8.63	3.05	.0354	.0569	.0357	.0212	.44	.0015	.0006	.98	–
1910, . . .	.57	9.82	4.39	.0655	.0622	.0426	.0196	.60	.0040	.0011	.84	–
1911, . . .	.70	9.15	3.37	.0396	.0554	.0375	.0179	.48	.0015	.0003	.98	–
1912, . . .	.62	10.93	3.23	.0592	.0717	.0491	.0226	.61	.0015	.0014	.95	–
1913, . . .	.66	9.74	2.97	.0525	.0634	.0432	.0202	.51	.0023	.0005	.96	–
1914, . . .	.60	10.47	3.15	.0501	.0704	.0488	.0216	.53	.0012	.0006	.82	–
1915, . . .	.76	9.43	3.41	.0317	.0746	.0427	.0319	.42	–	–	1.16	–
1916, . . .	.79	7.37	2.82	.0148	.0451	.0334	.0117	.36	–	–	1.04	–

[1] September omitted.

Quaboag River, below Palmer.

1899, . . .	.35	4.54	1.68	.0048	.0252	.0208	.0044	.26	.0060	.0002	.44	1.1
1900, . . .	.40	4.56	1.58	.0038	.0218	.0176	.0042	.26	.0062	.0001	.48	1.2
1901, . . .	.42	4.32	1.74	.0043	.0255	.0202	.0053	.23	.0052	.0002	.53	1.1
1902, . . .	.41	4.55	1.64	.0077	.0242	.0196	.0046	.33	.0085	.0002	.53	1.2
1903, . . .	.44	4.36	1.67	.0090	.0242	.0186	.0056	.27	.0092	.0003	.51	1.0
1904, . . .	.40	4.68	1.70	.0191	.0253	.0195	.0058	.31	.0082	.0002	.50	1.1
1908, . . .	.36	5.31	1.98	.0061	.0207	.0149	.0058	.40	.0070	.0003	.42	–
1909, . . .	.31	5.43	1.95	.0068	.0211	.0165	.0046	.41	.0058	.0003	.47	–
1910, . . .	.44	6.05	2.28	.0043	.0238	.0168	.0070	.52	.0057	.0003	.73	–
1911,[1] . . .	.39	5.94	2.08	.0060	.0191	.0145	.0046	.44	.0032	.0002	.53	–
1912, . . .	.40	7.63	2.08	.0087	.0209	.0144	.0065	.46	.0068	.0001	.58	–
1913,[2] . . .	.58	7.67	1.81	.0108	.0278	.0164	.0114	.46	.0042	.0001	.61	–
1914, . . .	.49	6.62	1.62	.0144	.0243	.0176	.0067	.49	.0045	.0004	.35	–
1915, . . .	.56	6.00	2.12	.0128	.0336	.0236	.0100	.40	–	–	.62	–
1916, . . .	.64	6.02	2.54	.0134	.0278	.0209	.0069	.31	–	–	.70	–

[1] Four months.

[2] June omitted.

CHICOPEE RIVER.

CHEMICAL EXAMINATION OF WATER FROM CHICOPEE RIVER AND ITS TRIBUTARIES, ETC. — *Concluded.*

Swift River, below Bondsville.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908,[1] . . .	.34	5.45	2.42	.0047	.0217	.0132	.0085	.21	.0013	.0002	.44	–
1909,[2] . . .	.40	4.60	1.70	.0016	.0196	.0139	.0057	.22	.0000	.0001	.60	–
1910, . . .	.33	5.28	2.05	.0031	.0261	.0196	.0065	.25	.0010	.0001	.60	–
1911, . . .	.48	5.05	2.12	.0021	.0278	.0193	.0085	.21	.0007	.0000	.74	–
1912, . . .	.28	5.02	1.92	.0047	.0268	.0184	.0084	.21	.0008	.0001	.54	–
1913, . . .	.36	5.32	1.95	.0024	.0296	.0204	.0092	.26	.0008	.0001	.58	–
1914, . . .	.35	4.97	1.67	.0037	.0304	.0219	.0085	.20	.0025	.0002	.55	–
1915, . . .	.46	4.95	1.83	.0052	.0269	.0202	.0067	.24	–	–	.64	–
1916, . . .	.49	4.22	1.67	.0026	.0193	.0160	.0033	.18	–	–	.69	–

[1] Three months.

[2] Two months.

Chicopee River, above Chicopee.

1908,[1] . . .	.42	5.21	1.98	.0100	.0240	.0177	.0063	.33	.0056	.0003	.62	–
1909,[2] . . .	.38	5.82	2.08	.0094	.0220	.0162	.0058	.36	.0046	.0004	.46	–
1910, . . .	.45	6.14	2.06	.0099	.0239	.0191	.0048	.44	.0052	.0003	.50	–
1911, . . .	.48	6.12	2.10	.0081	.0275	.0184	.0091	.42	.0067	.0004	.57	–
1912, . . .	.41	6.83	2.03	.0159	.0287	.0221	.0066	.50	.0108	.0005	.47	–
1913, . . .	.43	6.68	2.13	.0146	.0302	.0211	.0091	.44	.0067	.0006	.50	–
1914, . . .	.33	6.50	2.00	.0163	.0278	.0212	.0066	.51	.0095	.0008	.40	–
1915, . . .	.61	6.45	1.98	.0168	.0295	.0242	.0053	.39	–	–	.64	–
1916,[3] . . .	.69	6.15	2.35	.0126	.0236	.0194	.0042	.32	–	–	.72	–

[1] October omitted.

[2] September omitted.

[3] Four months.

CONCORD RIVER.

A general statement of the condition of this river and its tributaries during the year 1916 will be found on pages 286 and 287.

CONCORD RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Sudbury River, below Saxonville.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1901, ...	.84	7.22	3.37	.0073	.0624	.0431	.0193	.38	.0050	.0005	1.05	1.9
1902, ...	.38	6.39	2.57	.0150	.0424	.0272	.0152	.60	.0103	.0005	.55	2.2
1903, ...	.52	7.77	2.78	.0028	.0549	.0296	.0253	.65	.0080	.0002	.83	2.1
1904, ...	.48	9.58	3.57	.0569	.0587	.0385	.0202	.87	.0193	.0032	.88	2.5
1906,[1]	.67	6.88	2.90	.0258	.0525	.0381	.0144	.56	.0058	.0004	.92	1.9
1907,[2]	.65	9.07	3.28	.1357	.0653	.0347	.0306	.84	.0063	.0004	.84	2.1
1908,[3]	.44	9.67	3.72	.0039	.0634	.0374	.0260	1.06	.0128	.0009	.69	–
1909, ...	.43	6.81	2.59	.0174	.0330	.0256	.0074	.64	.0043	.0005	.64	–
1910, ...	.49	9.78	3.45	.0454	.0606	.0345	.0261	.83	.0040	.0010	.65	–
1911, ...	.37	9.03	3.08	.0287	.0410	.0281	.0129	.92	.0120	.0009	.54	–
1912, ...	.49	8.83	2.75	.0238	.0366	.0253	.0113	1.19	.0137	.0031	.72	–
1913, ...	.69	7.28	2.56	.0152	.0347	.0291	.0056	.90	.0185	.0023	.77	–
1914, ...	.51	9.62	3.03	.0292	.0439	.0276	.0163	1.13	.0220	.0042	.61	–
1915, ...	.97	6.67	2.75	.0129	.0408	.0319	.0089	.73	–	–	1.04	–
1916,[1]	.62	7.20	2.10	.0315	.0311	.0264	.0047	.93	–	–	.74	–

[1] June omitted. [2] Three months. [3] August omitted.

Assabet River, above Westborough.

1909, ...	.56	6.01	2.20	.0048	.0217	.0194	.0023	.36	.0015	.0001	.69	–
1910, ...	.90	7.37	3.12	.0029	.0251	.0229	.0022	.38	.0035	.0001	.86	–
1911, ...	.97	8.02	3.39	.0061	.0441	.0354	.0087	.45	.0023	.0002	1.20	–
1912, ...	.72	7.00	2.36	.0073	.0255	.0228	.0027	.44	.0061	.0002	.87	–
1913, ...	1.25	8.26	3.73	.0095	.0469	.0392	.0077	.46	.0007	.0002	1.55	–
1914, ...	.92	7.37	2.78	.0088	.0356	.0304	.0052	.41	.0034	.0001	.98	–
1915, ...	1.56	8.08	4.02	.0046	.0453	.0406	.0047	.46	–	–	1.74	–
1916, ...	1.01	7.52	3.20	.0033	.0298	.0260	.0038	.47	–	–	1.24	–

CONCORD RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES, ETC. — *Continued.*

Assabet River, below Westborough.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1909, ...	1.70	19.24	8.91	.4140	.2281	.1616	.0665	1.94	.0005	.0005	2.90	–
1910, ...	2.23	17.07	7.00	.2898	.1334	.1018	.0316	2.16	.0078	.0018	2.20	–
1911, ...	.83	12.09	4.01	.0556	.0460	.0373	.0087	1.87	.0967	.0121	1.24	–
1912, ...	.66	12.71	4.01	.0975	.0419	.0357	.0062	2.20	.1998	.0132	.95	–
1913, ...	1.15	9.67	4.21	.0152	.0448	.0401	.0047	1.08	.1078	.0016	1.37	–
1914, ...	.80	10.21	3.14	.0089	.0399	.0339	.0060	1.59	.0195	.0005	1.01	–
1915, ...	1.62	9.46	4.28	.0118	.0539	.0438	.0101	.87	–	–	1.83	–
1916, ...	.88	11.30	4.38	.0807	.0360	.0319	.0041	1.87	–	–	1.12	–

Assabet River, above Hudson.

1908,[1]	.49	5.97	2.16	.0044	.0241	.0200	.0041	.54	.0072	.0003	.59	–
1909, ...	.39	6.37	2.33	.0070	.0306	.0261	.0045	.52	.0037	.0002	.50	–
1910, ...	.57	6.90	3.08	.0058	.0346	.0296	.0050	.61	.0055	.0002	.67	–
1911, ...	.57	6.82	2.51	.0059	.0295	.0248	.0047	.57	.0077	.0002	.81	–
1912, ...	.45	6.51	2.13	.0075	.0297	.0234	.0063	.62	.0108	.0002	.59	–
1913,[2]	.65	8.48	2.81	.0168	.0386	.0327	.0059	.70	.0046	.0002	.79	–
1914, ...	.44	6.80	2.10	.0066	.0275	.0222	.0053	.65	.0060	.0001	.53	–
1915, ...	.82	6.48	2.63	.0064	.0325	.0305	.0020	.55	–	–	1.02	–
1916, ...	.54	6.68	2.73	.0053	.0236	.0208	.0028	.61	–	–	.62	–

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[1] September omitted.

[2] November omitted.

CONCORD RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONCORD RIVER AND ITS TRIBUTARIES, ETC. — *Continued.*

Assabet River, below Hudson.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898, ...	.79	5.61	2.38	.0062	.0335	.0291	.0044	.39	.0063	.0003	.87	1.6
1899, ...	.50	8.30	3.01	.0205	.0457	.0383	.0074	.80	.0020	.0004	.73	2.1
1900, ...	.48	8.05	2.05	.0382	.0501	.0362	.0139	1.27	.0028	.0007	.72	2.0
1901, ...	.66	5.47	2.38	.0193	.0375	.0295	.0080	.79	.0107	.0005	.91	1.8
1902, ...	.64	7.06	2.69	.0189	.0464	.0330	.0134	.84	.0077	.0005	.74	1.9
1903,[1]	.51	5.71	2.17	.0092	.0287	.0222	.0065	.56	.0073	.0006	.60	1.7
1904,[2]	.44	7.67	2.60	.0329	.0375	.0312	.0063	1.43	.0073	.0005	.64	1.9
1908, . . .	.51	9.17	3.50	.0198	.0396	.0294	.0102	1.32	.0072	.0005	.82	–
1909, ...	.51	8.81	3.26	.0161	.0403	.0296	.0107	.98	.0022	.0002	.64	–
1910, ...	.69	13.83	3.83	.0413	.0428	.0337	.0091	1.27	.0048	.0002	1.24	–
1911, ...	.64	12.83	4.30	.0817	.0532	.0400	.0132	.90	.0043	.0003	1.06	–
1912, ...	.78	18.08	3.99	.0939	.0752	.0494	.0258	1.02	.0053	.0002	1.28	–
1913,[3]	.76	13.29	3.34	.0727	.0704	.0577	.0127	1.07	.0036	.0004	1.28	–
1914, ...	.57	11.88	3.10	.0720	.0601	.0436	.0165	.98	.0042	.0002	1.03	–
1915, ...	.90	8.25	3.17	.0144	.0466	.0356	.0110	.59	–	–	1.16	–
1916, ...	.64	11.03	3.95	.0398	.0509	.0377	.0132	.70	–	–	.89	–

[1] June omitted. [2] Three months. [3] November omitted.

Assabet River, above Maynard.

1904, ...	.53	5.65	2.30	.0046	.0275	.0231	.0044	.64	.0035	.0001	.63	1.6
1906, ...	.75	5.53	2.26	.0065	.0290	.0254	.0036	.48	.0035	.0002	.97	1.5
1907,[1]	.68	5.35	1.80	.0047	.0255	.0211	.0044	.50	.0043	.0002	.73	1.6
1908, ...	.52	6.91	2.32	.0093	.0288	.0248	.0040	1.03	.0030	.0002	.62	–
1909, ...	.43	6.18	2.13	.0068	.0343	.0277	.0066	.72	.0023	.0001	.62	–
1910, ...	.54	7.70	2.82	.0098	.0337	.0291	.0046	.98	.0017	.0003	.64	–
1911, ...	.57	7.67	2.33	.0087	.0327	.0277	.0050	.85	.0065	.0004	.73	–
1912, ...	.57	7.92	2.15	.0058	.0316	.0242	.0074	1.06	.0032	.0002	.65	–
1913, ...	.60	7.85	2.27	.0085	.0372	.0296	.0076	1.03	.0028	.0003	.73	–
1914, ...	.46	7.02	2.39	.0069	.0373	.0308	.0065	.82	.0014	.0002	.53	–
1915, ...	.92	7.08	2.63	.0104	.0403	.0336	.0067	.63	–	–	1.03	–
1916, ...	.64	7.25	2.47	.0127	.0302	.0260	.0042	.67	–	–	.81	–

[1] Four months.

CONCORD RIVER.

Chemical Examination of Water from Concord River and its Tributaries, etc. — *Concluded.*

Assabet River, below Maynard.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898,	.77	5.93	2.59	.0020	.0387	.0301	.0086	.43	.0030	.0003	.89	1.5
1899,	.51	6.70	2.21	.0185	.0414	.0327	.0087	.73	.0043	.0003	.62	1.7
1900,	.50	5.72	1.73	.0217	.0386	.0304	.0082	.70	.0031	.0002	.59	1.4
1901,	.73	6.57	2.67	.0211	.0428	.0351	.0077	.45	.0052	.0002	.90	1.6
1902,	.69	7.27	2.87	.0099	.0592	.0381	.0211	.57	.0033	.0002	.83	1.6
1903,	.61	6.40	2.58	.0170	.0457	.0322	.0135	.48	.0037	.0003	.83	1.6
1904,	–	8.48	3.21	.0143	.0678	.0412	.0266	.74	.0043	.0002	1.05	1.7
1906,	.88	6.68	2.64	.0290	.0448	.0312	.0136	.58	.0047	.0003	.91	1.6
1907,[1]	.79	7.64	2.76	.0299	.0391	.0274	.0117	.69	.0060	.0003	.86	1.6
1908,	.45	11.46	3.98	.0675	.0684	.0381	.0303	1.37	.0028	.0012	.89	–
1909,	–	13.97	4.21	.1208	.0991	.0529	.0462	1.22	.0007	.0006	1.34	–
1910,	.59	13.15	4.68	.0708	.0685	.0446	.0239	1.82	.0038	.0006	.85	–
1911,	.58	12.73	4.17	.0738	.0650	.0408	.0242	1.41	.0060	.0006	1.08	–
1912,	–	12.94	3.92	.1205	.0771	.0494	.0277	1.46	.0026	.0010	1.04	–
1913,	.60	10.60	3.01	.0746	.0597	.0394	.0203	1.34	.0311	.0007	.85	–
1914,	.33	11.58	2.87	.0705	.0595	.0378	.0217	1.32	.0056	.0012	.73	–
1915,	.69	10.78	3.25	.0509	.0610	.0353	.0257	1.27	–	–	.99	–
1916,	.83	11.27	3.98	.0191	.0576	.0364	.0212	1.13	–	–	1.32	–

[1] Four months.

Concord River, at Billerica.

1902,	.68	5.98	2.18	.0091	.0347	.0272	.0075	.53	.0052	.0004	.78	1.7
1903,	.64	5.71	2.26	.0097	.0317	.0258	.0059	.49	.0058	.0005	.72	1.8
1904,	.64	6.05	2.31	.0077	.0341	.0255	.0086	.55	.0072	.0002	.75	1.7
1908,	.37	8.04	2.65	.0107	.0251	.0216	.0035	.96	.0104	.0005	.54	–
1909,	.49	7.71	2.78	.0128	.0298	.0267	.0031	.75	.0058	.0013	.65	–
1910,	.49	7.31	3.00	.0142	.0325	.0292	.0033	1.01	.0055	.0004	.58	–
1911,	.45	11.14	4.05	.0181	.0525	.0287	.0238	1.16	.0132	.0008	1.14	–
1912,[1]	.53	10.90	3.08	.0187	.0433	.0274	.0159	.97	.0140	.0008	.82	–
1913,	.57	7.63	2.38	.0089	.0355	.0312	.0043	.98	.0073	.0003	.77	–
1914,	.41	8.78	2.20	.0096	.0335	.0284	.0051	1.10	.0072	.0005	.50	–
1915,	.88	7.92	2.93	.0157	.0411	.0375	.0036	.84	–	–	1.05	–
1916,	.62	8.60	2.87	.0130	.0292	.0256	.0036	.85	–	–	.78	–

[1] September omitted.

CONNECTICUT RIVER.

A general statement of the condition of this river during the year 1916 will be found on page 287.

CONNECTICUT RIVER.

CHEMICAL EXAMINATION OF WATER FROM CONNECTICUT RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Connecticut River, at Northfield Farms.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899,	.30	7.32	2.17	.0016	.0189	.0158	.0031	.11	.0023	.0001	.85	3.6
1900,	.47	6.24	2.11	.0023	.0190	.0154	.0036	.09	.0030	.0001	.95	2.9
1901,	.31	6.12	2.39	.0016	.0146	.0122	.0024	.10	.0037	.0002	.72	3.2
1902,	.30	5.57	2.02	.0014	.0124	.0110	.0014	.08	.0057	.0001	.60	2.9
1903,	.23	6.83	2.18	.0037	.0169	.0143	.0026	.14	.0028	.0002	.68	3.4
1904,[1]	.27	6.44	2.44	.0023	.0158	.0130	.0028	.12	.0038	.0001	.73	3.4
1906,	.34	6.50	2.17	.0040	.0201	.0181	.0020	.14	.0023	.0002	.76	3.2
1907,[2]	.36	5.91	2.06	.0020	.0141	.0122	.0019	.16	.0048	.0002	.66	3.0
1908,[3]	.28	8.33	2.78	.0058	.0200	.0177	.0023	.22	.0018	.0001	.70	–
1909,	.29	7.32	2.89	.0031	.0142	.0124	.0018	.16	.0017	.0002	.82	–
1910,	.31	7.52	3.10	.0064	.0174	.0152	.0022	.17	.0018	.0001	.77	–
1911,	.32	7.28	2.44	.0066	.0172	.0143	.0029	.16	.0022	.0001	.70	–
1912,	.36	7.43	1.63	.0066	.0185	.0148	.0037	.16	.0012	.0001	.70	–
1913,	.31	7.78	2.31	.0077	.0174	.0131	.0043	.17	.0020	.0002	.65	–
1914,	.29	8.03	2.73	.0056	.0182	.0137	.0045	.17	.0012	.0001	.70	–
1915,	.30	7.08	2.08	.0031	.0162	.0124	.0038	.17	–	–	.60	–
1916,[4]	.37	6.90	2.10	.0032	.0152	.0135	.0017	.14	–	–	.80	–

[1] July omitted. [2] Four months. [3] June omitted. [4] August omitted.

Connecticut River, below Springfield.

YEAR.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1888,	.35	5.34	1.24	.0032	.0182	.0143	.0039	.15	.0082	.0002	–	–
1899,	.33	6.61	1.99	.0093	.0238	.0195	.0043	.23	.0042	.0003	.67	3.1
1900,	.44	6.64	1.90	.0098	.0250	.0176	.0074	.20	.0034	.0002	.89	3.1
1901,	.32	6.03	2.34	.0061	.0190	.0153	.0037	.18	.0048	.0003	.65	3.0
1902,	.31	5.83	2.13	.0062	.0180	.0140	.0040	.16	.0055	.0005	.61	3.0
1903,	.30	6.12	2.04	.0098	.0202	.0147	.0055	.24	.0058	.0004	.61	2.7
1904,[1]	.22	5.22	1.87	.0098	.0187	.0125	.0062	.21	.0047	.0002	.48	2.4
1906,[2]	.35	7.14	2.61	.0082	.0204	.0161	.0043	.24	.0026	.0004	.71	2.8
1907,[3]	.38	6.27	2.46	.0069	.0163	.0131	.0032	.24	.0050	.0003	.67	2.9
1908,	.32	8.58	2.61	.0214	.0223	.0165	.0058	.38	.0040	.0004	.81	–
1909,	.29	6.02	2.25	.0079	.0156	.0118	.0038	.22	.0018	.0003	.65	–
1910,	.33	8.67	3.60	.0155	.0241	.0188	.0053	.37	.0028	.0003	.89	–
1911,	.38	7.66	2.56	.0140	.0181	.0147	.0034	.28	.0018	.0005	.70	–
1912,	.31	8.22	3.02	.0136	.0228	.0161	.0067	.16	.0022	.0004	.74	–
1913,[4]	.31	7.96	2.50	.0178	.0242	.0181	.0061	.35	.0038	.0004	.68	–
1914,	.29	7.92	2.50	.0185	.0243	.0178	.0065	.30	.0023	.0003	.82	–
1915,	.35	7.15	2.38	.0091	.0216	.0151	.0065	.24	–	–	.69	–
1916,	.37	7.82	3.09	.0067	.0173	.0143	.0030	.20	–	–	.77	–

[1] Three months. [2] June omitted. [3] Four months. [4] September omitted.

Deerfield River.

A general statement of the condition of this river in the year 1916 will be found on page 288.

DEERFIELD RIVER.

Chemical Examination of Water from Deerfield River and Tributary. — Averages for Six Months, from June to November, inclusive.

Deerfield River, at Shelburne Falls.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1901,	.34	4.02	1.82	.0057	.0200	.0171	.0029	.09	.0078	.0001	.63	1.7
1902,	.29	3.62	1.46	.0051	.0151	.0126	.0025	.08	.0055	.0002	.51	1.7
1903,[1]	.26	3.74	1.35	.0023	.0131	.0113	.0018	.09	.0038	.0002	.44	1.5
1904,	.24	4.15	1.52	.0040	.0115	.0097	.0018	.11	.0110	.0001	.39	2.1
1908,	.33	4.93	1.93	.0017	.0128	.0108	.0020	.14	.0030	.0001	.44	–
1909,	.26	4.56	1.62	.0009	.0150	.0129	.0021	.12	.0005	.0001	.47	–
1910,	.26	4.62	1.69	.0025	.0141	.0108	.0033	.13	.0010	.0001	.45	–
1911,	.35	4.80	1.88	.0035	.0156	.0119	.0037	.13	.0027	.0000	.59	–
1912,[2]	.29	4.48	1.65	.0024	.0149	.0122	.0027	.11	.0008	.0001	.42	–
1913,	.39	4.55	1.30	.0049	.0213	.0164	.0049	.12	.0007	.0000	.53	–
1914,	.45	4.80	1.57	.0062	.0222	.0167	.0055	.17	.0022	.0003	.56	–
1915,	.27	4.58	1.44	.0042	.0149	.0121	.0028	.16	–	–	.39	–
1916,[1]	.34	4.50	2.23	.0033	.0129	.0117	.0012	.23	–	–	.55	–

[1] Four months.

[2] October omitted.

Green River, below Greenfield.

Year.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1903,	.05	7.75	2.23	.0152	.0143	.0086	.0057	.21	.0078	.0005	.15	3.9
1904,	.07	6.93	2.01	.0151	.0382	.0138	.0244	.28	.0100	.0006	.22	3.8
1908,	.17	11.06	2.97	.0665	.0337	.0131	.0206	.45	.0043	.0011	.33	–
1909,	.14	7.82	2.54	.0459	.0333	.0151	.0182	.37	.0038	.0011	.23	–
1910,	.17	8.33	3.16	.0775	.0284	.0169	.0115	.37	.0025	.0012	.23	–
1911,	.21	9.23	2.44	.0684	.0228	.0115	.0113	.48	.0033	.0014	.37	–
1912,	.17	18.02	2.71	.0099	.0352	.0092	.0260	.23	.0017	.0003	.44	–
1913,	.12	8.25	2.25	.0203	.0198	.0103	.0095	.26	.0030	.0003	.22	–
1914,	.13	9.15	1.60	.0426	.0234	.0135	.0099	.38	.0038	.0007	.17	–
1915,[1]	.10	6.95	1.15	.0348	.0184	.0102	.0082	.28	–	–	.20	–
1916,	.08	10.26	2.42	.0284	.0161	.0084	.0077	.34	–	–	.22	–

[1] Four months.

Deerfield River, below Green River.

Year.	Color.	Residue Total.	Loss on Ignition.	Ammonia Free.	Albuminoid Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Hardness.
1908,	.26	7.35	2.28	.0075	.0154	.0098	.0056	.20	.0025	.0002	.37	–
1909,	.28	5.55	1.83	.0043	.0121	.0104	.0017	.14	.0012	.0001	.41	–
1910,	.24	5.82	2.37	.0093	.0128	.0112	.0016	.16	.0008	.0003	.31	–
1911,	.34	5.82	2.06	.0078	.0143	.0106	.0037	.16	.0025	.0005	.52	–
1912,	.25	5.23	1.63	.0070	.0140	.0107	.0033	.17	.0030	.0001	.37	–
1913,	.28	5.39	1.60	.0113	.0257	.0183	.0074	.17	.0063	.0002	.39	–
1914,	.30	5.68	1.80	.0124	.0182	.0143	.0039	.19	.0020	.0001	.43	–
1915,[1]	.22	5.41	1.28	.0211	.0195	.0128	.0067	.20	–	–	.34	–
1916,	.29	5.60	1.47	.0226	.0160	.0127	.0033	.21	–	–	.43	–

[1] Four months.

FRENCH RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 288.

FRENCH RIVER.

CHEMICAL EXAMINATION OF WATER FROM FRENCH RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

French River, below Webster.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, ...	.44	5.67	2.07	.0238	.0612	.0384	.0228	.42	.0024	.0007	.66	1.6
1900, ...	.52	5.79	2.10	.0202	.0475	.0357	.0118	.46	.0062	.0007	.78	1.5
1901, ...	.50	5.29	2.25	.0090	.0390	.0265	.0125	.33	.0044	.0002	.75	1.2
1902, ...	.42	4.92	1.99	.0057	.0391	.0264	.0127	.39	.0038	.0002	.65	1.2
1903, ...	.48	4.67	1.88	.0049	.0352	.0241	.0111	.40	.0058	.0002	.72	0.9
1904, ...	.44	6.02	2.18	.0267	.0434	.0281	.0153	.58	.0042	.0004	.70	1.3
1906, ...	.61	5.08	2.19	.0063	.0353	.0246	.0107	.40	.0038	.0003	.81	0.9
1907,[1] . . .	.54	6.28	2.62	.0117	.0544	.0304	.0240	.49	.0035	.0004	.69	1.2
1908, ...	.44	7.17	2.82	.0086	.0507	.0310	.0197	.61	.0037	.0010	.81	–
1909, ...	.50	7.42	2.61	.0267	.0638	.0385	.0253	.77	.0055	.0012	.72	–
1910, ...	.44	8.27	3.55	.0512	.0527	.0321	.0206	.78	.0016	.0021	.79	–
1911, ...	.57	10.23	3.17	.0219	.0652	.0405	.0247	.89	.0015	.0004	.94	–
1912, ...	.49	9.78	3.77	.0420	.0745	.0399	.0346	.82	.0060	.0021	.87	–
1913, ...	.53	8.42	2.93	.0345	.0641	.0358	.0283	.72	.0042	.0007	.86	–
1914, ...	.40	8.50	2.48	.0500	.0675	.0399	.0276	.72	.0018	.0027	.69	–
1915, ...	.53	8.38	3.02	.0472	.0778	.0448	.0330	.80	–	–	.88	–
1916, ...	.60	8.03	2.55	.0521	.0593	.0402	.0191	.84	–	–	.86	–

[1] Four months.

Hoosick River.

A general statement of the condition of this river in the year 1916 will be found on page 288.

HOOSICK RIVER.

Chemical Examination of Water from Hoosick River. — Averages for Six Months, from June to November, inclusive.

Hoosick River, at Williamstown.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887,	.22	12.05	1.22	.0065	.0190	–	–	.23	.0232	–	–	–
1888,	.12	10.82	1.90	.0026	.0210	.0142	.0068	.27	.0247	.0015	–	–
1894,	.37	13.56	2.74	.0166	.0361	.0224	.0137	.50	.0102	.0014	.42	9.0
1895,	.34	14.20	3.26	.0190	.0424	.0241	.0183	.63	.0090	.0020	.53	9.0
1896,	.21	11.71	2.39	.0295	.0267	.0172	.0095	.39	.0133	.0018	.33	8.6
1897,	.26	11.32	2.39	.0174	.0312	.0173	.0139	.30	.0265	.0011	.31	7.9
1898,	.27	10.46	2.38	.0223	.0311	.0210	.0101	.31	.0170	.0007	.34	6.6
1899,	.30	15.21	3.31	.0252	.0622	.0379	.0243	.64	.0070	.0029	.62	8.3
1900,	.28	14.20	2.79	.0433	.0547	.0301	.0246	.60	.0087	.0043	.58	7.8
1901,	.27	13.02	3.70	.0400	.0520	.0250	.0270	.43	.0152	.0024	.53	7.3
1902,	.22	10.62	2.87	.0069	.0307	.0172	.0135	.34	.0123	.0014	.40	6.4
1903,	.17	10.50	2.37	.0272	.0264	.0151	.0113	.29	.0183	.0019	.33	7.5
1904,	.13	12.30	3.23	.0677	.0310	.0191	.0119	.45	.0203	.0024	.29	8.3
1905,	.20	11.09	2.81	.0295	.0265	.0156	.0109	.32	.0123	.0015	.31	5.6
1906,	.31	13.28	3.63	.0415	.0489	.0252	.0237	.47	.0147	.0030	.43	6.0
1907,	.25	11.80	2.93	.0431	.0390	.0231	.0159	.47	.0135	.0021	.39	7.9
1908,	.23	14.00	3.86	.0559	.0323	.0195	.0128	.54	.0085	.0023	.37	–
1909,	.23	15.46	4.09	.0496	.0382	.0243	.0139	.62	.0060	.0035	.41	–
1910,	.30	13.06	4.43	.0320	.0336	.0219	.0117	.52	.0102	.0018	.41	–
1911,	.26	12.38	3.77	.1153	.0492	.0232	.0260	.58	.0065	.0022	.43	–
1912,	.24	15.05	3.35	.0365	.0464	.0280	.0184	.73	.0058	.0025	.45	9.3
1913,	.13	17.57	3.78	.0638	.0489	.0310	.0179	.88	.0053	.0024	.49	9.2
1914,	.39	18.62	4.02	.0670	.0584	.0381	.0203	.83	.0037	.0015	.63	9.5
1915,	.21	12.65	2.60	.0351	.0316	.0202	.0114	.49	–	–	.32	6.9
1916,[1]	.29	12.93	4.10	.0422	.0294	.0195	.0099	.67	–	–	.40	7.2

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[1] August omitted.

HOUSATONIC RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 288.

HOUSATONIC RIVER.

CHEMICAL EXAMINATION OF WATER FROM HOUSATONIC RIVER AND ITS BRANCHES. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

East Branch, below Pittsfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1903,	.32	9.75	2.92	.0118	.0226	.0153	.0073	.25	.0142	.0006	.56	6.8
1904,[1]	.28	9.02	3.15	.0117	.0248	.0175	.0073	.26	.0113	.0005	.47	6.2
1907,[2]	.42	9.40	3.00	.0286	.0284	.0186	.0098	.28	.0060	.0010	.50	6.4
1908,[3]	.29	12.76	3.57	.0327	.0250	.0177	.0073	.40	.0140	.0011	.47	–
1909,	.26	12.60	4.37	.0431	.0305	.0215	.0090	.33	.0087	.0007	.44	–
1910,	.30	12.98	5.26	.0437	.0233	.0182	.0051	.40	.0080	.0012	.48	–
1911,[1]	.29	12.03	4.26	.0231	.0253	.0169	.0084	.37	.0060	.0011	.54	–
1912,[1]	.28	13.08	3.18	.0358	.0337	.0236	.0101	.43	.0123	.0010	.62	–
1913,	.32	15.34	3.60	.0526	.0405	.0259	.0146	.48	.0073	.0019	.69	–
1914,[4]	.24	13.82	3.27	.0509	.0351	.0271	.0080	.47	.0087	.0015	.53	–
1915,	.37	11.98	3.23	.0527	.0304	.0236	.0068	.35	–	–	.60	–
1916,	.34	12.67	4.00	.0496	.0292	.0225	.0067	.40	–	–	.54	–

[1] Three months. [2] Two months. [3] November omitted. [4] Four months.

West Branch, below Pittsfield.

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1903,	.29	10.43	2.83	.0100	.0210	.0143	.0067	.23	.0143	.0006	.46	7.4
1904,[1]	.15	12.27	3.50	.0137	.0423	.0217	.0206	.35	.0050	.0004	.35	7.8
1908,[2]	.20	13.28	3.68	.0210	.0301	.0194	.0107	.26	.0026	.0009	.36	–
1909,	–	11.00	2.87	.0070	.0283	.0175	.0108	.24	.0010	.0003	.25	–
1910,	.22	13.85	4.98	.0218	.0446	.0218	.0228	.40	.0012	.0011	.40	–
1911,[1]	.19	12.73	4.70	.0090	.0317	.0184	.0133	.26	.0030	.0005	.37	–
1912,[1]	.17	12.60	2.70	.0081	.0360	.0197	.0163	.29	.0037	.0005	.41	–
1913,	.30	18.72	5.10	.0870	.0779	.0397	.0382	.78	.0020	.0008	.82	–
1914,[3]	.20	14.62	2.75	.0288	.0495	.0313	.0182	.45	.0017	.0011	.61	–
1915,[4]	.34	16.62	3.72	.0671	.0691	.0359	.0332	.65	–	–	.63	–
1916,	.18	12.93	3.78	.0568	.0432	.0228	.0204	.46	–	–	.29	–

[1] Three months. [2] November omitted. [3] Four months. [4] September omitted.

HOUSATONIC RIVER.

CHEMICAL EXAMINATION OF WATER FROM HOUSATONIC RIVER AND ITS BRANCHES, ETC. — *Concluded.*

Southwest Branch, at Pittsfield.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899,	.17	14.92	2.58	.0040	.0353	.0211	.0142	.16	.0108	.0004	.37	9.2
1900,	.14	14.87	2.15	.0192	.0335	.0229	.0106	.21	.0107	.0008	.35	10.2
1901,	.14	13.20	3.87	.0051	.0302	.0197	.0105	.16	.0096	.0004	.41	9.4
1902,	.11	12.30	3.09	.0057	.0224	.0136	.0088	.12	.0108	.0005	.37	8.7
1903,	.10	11.63	2.37	.0045	.0162	.0109	.0053	.11	.0115	.0003	.25	8.8
1904,[1]	.15	12.45	3.63	.0116	.0455	.0223	.0232	.34	.0040	.0018	.35	7.8
1907,[2]	.31	10.78	2.30	.0040	.0258	.0168	.0090	.20	.0025	.0003	.39	8.2
1908,[3]	.18	15.17	4.89	.0216	.0269	.0159	.0110	.23	.0036	.0007	.38	–
1909,	.17	14.82	4.41	.0041	.0265	.0153	.0112	.23	.0082	.0005	.37	–
1910,	.17	14.45	5.25	.0049	.0196	.0135	.0061	.17	.0045	.0006	.30	–
1911,[1]	.14	12.62	3.35	.0013	.0224	.0131	.0093	.19	.0110	.0005	.34	–
1912,[1]	.12	15.02	3.08	.0017	.0172	.0111	.0061	.21	.0170	.0007	.31	–
1913,	.13	15.97	3.34	.0037	.0221	.0157	.0064	.20	.0115	.0009	.32	–
1914,[4]	.16	15.05	2.30	.0098	.0259	.0166	.0093	.24	.0072	.0005	.37	–
1915,	.14	15.25	2.95	.0070	.0243	.0159	.0084	.26	–	–	.30	–
1916,	.15	14.97	4.69	.0038	.0197	.0122	.0075	.20	–	–	.30	–

[1] Three months. [2] Two months. [3] November omitted. [4] Four months.

Housatonic River, below Great Barrington.

1908,	.18	14.97	3.69	.0106	.0269	.0172	.0097	.43	.0107	.0011	.36	–
1909,	.16	14.91	4.41	.0067	.0247	.0173	.0074	.47	.0078	.0012	.35	–
1910,	.22	14.97	5.32	.0128	.0233	.0181	.0052	.51	.0090	.0021	.34	–
1911,	.19	14.42	5.29	.0178	.0217	.0157	.0060	.45	.0087	.0045	.40	–
1912,[1]	.22	14.56	3.79	.0123	.0272	.0189	.0083	.47	.0120	.0028	.42	–
1913,	.21	18.60	5.48	.0117	.0444	.0265	.0179	.67	.0085	.0030	.77	–
1914,[2]	.22	17.62	4.22	.0147	.0372	.0268	.0104	.69	.0112	.0023	.42	–
1915,	.23	15.83	3.60	.0142	.0296	.0183	.0113	.46	–	–	.47	–
1916,[3]	.22	15.40	5.80	.0143	.0230	.0174	.0056	.49	–	–	.40	–

[1] August omitted. [2] Four months. [3] June omitted.

MERRIMACK RIVER.

A general statement of the condition of this river during the year 1916 will be found on page 289.

MERRIMACK RIVER.

CHEMICAL EXAMINATION OF WATER FROM MERRIMACK RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Merrimack River, above Lowell.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887,	.45	4.08	1.10	.0024	.0156	–	–	.17	.0078	–	–	–
1888,	.32	3.47	1.01	.0014	.0161	.0137	.0024	.16	.0082	.0002	–	–
1889,	.37	–	–	.0028	.0166	.0143	.0023	.17	.0067	.0001	–	–
1890,	.34	3.85	1.58	.0025	.0148	.0123	.0025	.14	.0106	.0002	–	1.4
1891,	.27	3.73	1.47	.0029	.0147	.0111	.0036	.17	.0080	.0002	–	1.4
1892,	.39	3.75	1.37	.0028	.0139	.0106	.0033	.15	.0097	.0002	–	1.6
1893,	.25	3.47	1.13	.0028	.0141	.0110	.0031	.17	.0072	.0001	.38	1.1
1894,	.29	3.86	1.32	.0037	.0140	.0114	.0026	.19	.0042	.0001	.36	1.2
1895,	.43	3.97	1.61	.0019	.0197	.0151	.0046	.24	.0054	.0001	.55	1.2
1896,	.44	3.85	1.41	.0049	.0181	.0149	.0032	.18	.0053	.0002	.66	1.0
1897,	.54	3.62	1.68	.0030	.0181	.0148	.0033	.16	.0077	.0001	.52	0.9
1898,	.39	3.93	1.74	.0032	.0197	.0171	.0026	.19	.0047	.0001	.51	1.0
1899,	.20	3.88	1.45	.0050	.0205	.0166	.0039	.22	.0055	.0002	.38	1.2
1900,	.23	3.72	1.21	.0068	.0215	.0158	.0057	.23	.0038	.0002	.44	1.3
1901,	.38	4.32	1.98	.0060	.0208	.0172	.0036	.20	.0042	.0002	.69	1.2
1902,	.38	3.81	1.59	.0056	.0163	.0142	.0021	.17	.0043	.0001	.64	0.9
1903,	.30	4.00	1.55	.0058	.0171	.0129	.0042	.23	.0040	.0002	.59	1.1
1904,	.33	4.61	1.92	.0077	.0194	.0153	.0041	.23	.0047	.0002	.69	1.3
1905,	.40	4.30	1.95	.0112	.0202	.0160	.0042	.25	.0038	.0002	.71	1.1
1906,	.37	4.64	1.84	.0100	.0201	.0174	.0027	.26	.0032	.0002	.71	1.2
1907,	.38	4.60	1.88	.0079	.0194	.0135	.0059	.28	.0043	.0002	.62	1.2
1908,	.29	4.67	1.80	.0125	.0195	.0141	.0054	.36	.0048	.0003	.64	1.3
1909,	.31	5.16	2.38	.0185	.0213	.0161	.0052	.36	.0018	.0002	.68	1.5
1910,	.37	5.11	1.78	.0242	.0221	.0180	.0041	.35	.0035	.0007	.68	1.4
1911,	.39	5.32	2.09	.0166	.0219	.0165	.0054	.36	.0033	.0006	.65	1.5
1912,	.40	5.16	1.94	.0165	.0223	.0175	.0048	.32	.0013	.0003	.88	2.0
1913,[1]	.36	5.56	1.66	.0162	.0277	.0189	.0088	.39	.0030	.0003	.70	1.8
1914,	.30	5.32	1.74	.0170	.0255	.0181	.0074	.35	.0037	.0003	.61	1.6
1915,	.46	5.43	2.18	.0140	.0273	.0205	.0068	.32	–	–	.79	1.3
1916,[2]	.50	6.02	2.06	.0078	.0197	.0169	.0028	.25	–	–	.77	1.3

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[1] June omitted.

[2] October omitted.

Chemical Examination of Water from Merrimack River, etc. — *Concluded.*

Merrimack River, above Lawrence.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1887, ...	.47	4.82	1.24	.0027	.0211	–	–	.22	.0097	–	–	–
1888, ...	.32	3.64	1.13	.0029	.0197	.0153	.0044	.18	.0074	.0003	–	–
1889, ...	.35	–	–	.0047	.0212	.0176	.0036	.20	.0053	.0002	–	–
1890, ...	.37	4.27	1.56	.0061	.0187	.0148	.0039	.19	.0068	.0002	–	1.6
1891, ...	.21	4.06	1.37	.0066	.0179	.0138	.0041	.21	.0090	.0002	–	1.4
1892, ...	.46	4.25	1.50	.0054	.0186	.0155	.0031	.19	.0087	.0002	–	1.5
1893, ...	.40	4.25	1.62	.0084	.0172	.0138	.0034	.23	.0057	.0003	.52	1.3
1894, ...	.32	3.82	1.35	.0086	.0174	.0142	.0032	.25	.0043	.0001	.40	1.3
1895, ...	.52	4.45	1.97	.0068	.0251	.0194	.0057	.30	.0067	.0003	.60	1.5
1896, ...	.46	4.24	1.70	.0100	.0224	.0181	.0043	.25	.0067	.0005	.57	1.3
1897, ...	.58	4.06	1.67	.0061	.0222	.0190	.0032	.21	.0053	.0002	.53	1.0
1898, ...	.44	4.46	1.87	.0076	.0262	.0208	.0054	.25	.0050	.0005	.59	1.3
1899, ...	.24	4.42	1.57	.0138	.0277	.0207	.0070	.32	.0052	.0004	.43	1.3
1900, ...	.27	4.22	1.35	.0126	.0249	.0190	.0059	.32	.0050	.0003	.46	1.3
1901, ...	.44	4.73	1.90	.0100	.0280	.0205	.0075	.28	.0070	.0006	.65	1.5
1902, ...	.42	4.40	1.85	.0110	.0231	.0180	.0051	.26	.0038	.0003	.65	1.1
1903, ...	.37	4.66	1.73	.0111	.0226	.0166	.0060	.31	.0052	.0005	.64	1.4
1904, ...	.31	4.67	1.80	.0211	.0247	.0170	.0077	.33	.0053	.0004	.62	1.4
1905, ...	.44	4.92	2.01	.0177	.0242	.0183	.0059	.38	.0040	.0005	.74	1.2
1906, ...	.39	5.30	2.12	.0170	.0263	.0215	.0048	.40	.0027	.0005	.72	1.4
1907, ...	.40	4.92	1.80	.0293	.0253	.0175	.0078	.41	.0047	.0005	.59	1.3
1908, ...	.33	5.61	2.19	.0354	.0303	.0196	.0107	.57	.0052	.0006	.74	1.5
1909, ...	.33	6.28	2.04	.0336	.0262	.0196	.0066	.53	.0025	.0007	.67	1.7
1910, ...	.39	–	–	.0266	.0242	.0183	.0059	.53	.0125	.0008	.57	1.6
1911, ...	.23	8.25	3.10	.0240	.0286	.0227	.0059	.53	.0118	.0007	.65	1.6
1912, ...	.21	6.49	2.62	.0241	.0225	.0188	.0037	.52	.0151	.0006	.59	1.3
1913, ...	.25	7.46	2.93	.0245	.0224	.0185	.0039	.57	.0167	.0007	.61	1.5
1914, ...	.23	6.85	2.62	.0280	.0246	.0201	.0045	.59	.0190	.0003	.59	1.7
1915, ...	.33	7.05	2.83	.0183	.0230	.0177	.0053	.47	.0139	.0002	.69	1.6
1916, ...	.47	6.89	2.77	.0143	.0211	.0146	.0065	.43	.0175	.0004	.55	1.4

MILLER'S RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 289.

MILLER'S RIVER.

CHEMICAL EXAMINATION OF WATER FROM MILLER'S RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Miller's River, below Miller's Falls.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908, ...	.54	4.59	2.06	.0054	.0233	.0181	.0052	.34	.0060	.0002	.64	–
1909, ...	.54	4.38	1.84	.0035	.0207	.0181	.0026	.34	.0030	.0002	.60	–
1910, ...	.55	5.48	2.28	.0068	.0231	.0202	.0029	.44	.0075	.0002	.68	–
1911, ...	.66	5.98	2.58	.0056	.0258	.0220	.0038	.35	.0052	.0002	.90	–
1912, ...	.51	5.30	2.17	.0047	.0242	.0202	.0040	.42	.0060	.0002	.61	–
1913, ...	.59	5.65	1.88	.0056	.0315	.0231	.0084	.36	.0081	.0002	.69	–
1914, ...	.44	5.17	1.85	.0073	.0251	.0204	.0047	.36	.0068	.0003	.49	–
1915, ...	.88	5.77	2.75	.0092	.0311	.0256	.0055	.31	–	–	.93	–
1916, ...	.80	4.85	2.14	.0093	.0274	.0212	.0062	.31	–	–	.97	–

NASHUA RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 289.

NASHUA RIVER.

CHEMICAL EXAMINATION OF WATER FROM NASHUA RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

North Branch of Nashua River, below Fitchburg.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1893,	.70	8.32	2.38	.0562	.0405	.0289	.0116	.73	.0097	.0030	.73	2.2
1894,	.66	9.18	2.22	.0987	.0425	.0308	.0117	.99	.0123	.0034	.64	2.4
1895,	.71	9.42	2.72	.1387	.0493	.0381	.0112	1.08	.0088	.0014	.82	2.6
1896,	.57	9.27	2.62	.0898	.0537	.0384	.0153	.95	.0127	.0030	.71	2.4
1897,	.67	7.62	2.50	.0512	.0518	.0389	.0129	.71	.0112	.0009	.79	2.1
1898,	.56	7.02	2.37	.0688	.0629	.0399	.0230	.56	.0097	.0016	.72	1.8
1899,	.53	10.12	2.95	.1507	.0848	.0537	.0311	1.03	.0055	.0013	.83	2.4
1900,	.42	9.55	2.42	.1575	.0825	.0479	.0346	1.03	.0080	.0015	.73	2.6
1901,	.42	8.45	2.58	.0964	.0508	.0347	.0161	.67	.0080	.0013	.69	2.2
1902,	.39	7.83	2.42	.1070	.0557	.0407	.0150	.68	.0072	.0012	.71	1.9
1903,	.38	7.21	2.10	.1200	.0471	.0281	.0190	.73	.0095	.0014	.62	1.7
1904,	.33	9.05	2.70	.1858	.0596	.0341	.0255	.88	.0077	.0015	.70	2.1
1905,	.48	7.66	2.33	.1284	.0568	.0354	.0214	.73	.0053	.0008	.89	2.1
1906,	.47	7.68	2.16	.1037	.0558	.0356	.0202	.75	.0083	.0020	.68	2.0
1907,	.50	10.77	2.72	.2180	.0654	.0350	.0304	1.24	.0065	.0012	.72	2.8
1908,	.52	15.05	3.60	.2605	.0861	.0494	.0367	1.58	.0033	.0016	1.04	–
1909,	.52	15.85	3.42	.3220	.0958	.0563	.0395	1.87	.0027	.0014	1.02	–
1910,	.60	20.11	4.90	.4047	.1235	.0789	.0446	2.29	.0017	.0009	1.03	–
1911,	.51	19.38	5.57	.2848	.1035	.0566	.0469	2.37	.0027	.0015	1.15	–
1912,	.57	19.52	4.99	.2380	.1007	.0560	.0447	2.20	.0032	.0019	1.22	–
1913,	.40	23.45	4.97	.2770	.1064	.0561	.0503	2.02	.0028	.0013	1.42	5.0
1914,	.41	26.93	5.78	.3260	.1156	.0662	.0494	2.60	.0020	.0006	1.55	5.9
1915,[1]	.41	14.68	3.52	.0578	.0745	.0296	.0449	1.26	–	–	.94	3.1
1916,[2]	.42	18.52	5.12	.1043	.0778	.0380	.0398	2.12	–	–	1.03	3.2

[1] October omitted.

[2] August omitted.

NASHUA RIVER.

Chemical Examination of Water from Nashua River, etc. — *Concluded.*

North Branch of Nashua River, at Lancaster.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1892, . . .	.48	9.75	2.10	.0422	.0274	.0237	.0037	1.11	.0450	.0010	–	3.0
1894, . . .	.49	8.07	1.97	.0215	.0226	.0182	.0044	.97	.0295	.0011	.49	2.2
1895, . . .	.51	8.28	2.39	.0318	.0272	.0214	.0058	1.01	.0284	.0034	.56	2.3
1896, . . .	.57	6.97	2.17	.0253	.0322	.0253	.0069	.66	.0167	.0034	.60	2.0
1897, . . .	.65	5.45	2.03	.0225	.0290	.0221	.0069	.40	.0153	.0015	.68	1.5
1898, . . .	.48	6.33	2.10	.0409	.0345	.0263	.0082	.56	.0227	.0033	.51	1.7
1899, . . .	.39	7.60	2.33	.0739	.0365	.0305	.0060	.75	.0153	.0028	.60	2.0
1900, . . .	.29	7.17	1.55	.0545	.0326	.0264	.0062	.81	.0202	.0039	.52	2.1
1901, . . .	.37	6.72	2.14	.0432	.0329	.0240	.0089	.54	.0087	.0021	.58	1.9
1902, . . .	.40	7.96	2.66	.0757	.0324	.0267	.0057	.70	.0188	.0043	.58	1.8
1903, . . .	.36	6.95	2.35	.0473	.0260	.0201	.0059	.58	.0258	.0034	.52	1.6
1904, . . .	.32	8.01	2.18	.0803	.0318	.0267	.0051	.80	.0267	.0040	.53	2.0
1905, . . .	.34	7.20	2.13	.0616	.0296	.0227	.0069	.70	.0207	.0044	.50	1.9
1906, . . .	.44	7.34	2.12	.0519	.0311	.0240	.0071	.72	.0238	.0027	.56	2.0
1907, . . .	.44	8.34	2.33	.0600	.0294	.0232	.0062	.89	.0333	.0084	.53	2.1
1908, . . .	.40	10.69	2.73	.1075	.0309	.0259	.0050	1.28	.0405	.0090	.58	–
1909, . . .	.44	12.26	3.41	.1556	.0330	.0284	.0046	1.46	.0360	.0066	.60	–
1910, . . .	.45	13.44	3.82	.1655	.0462	.0366	.0096	1.63	.0388	.0108	.70	–
1911, . . .	.51	15.64	4.10	.3067	.0828	.0408	.0420	1.95	.0208	.0083	.92	–
1912, . . .	.45	12.65	3.10	.1252	.0438	.0275	.0163	1.68	.0343	.0083	.72	–
1913, . . .	.43	15.45	3.02	.2292	.0533	.0386	.0147	1.75	.0133	.0053	.80	4.2
1914, . . .	.39	16.80	3.15	.2147	.0466	.0336	.0130	1.94	.0262	.0115	.67	4.1
1915, . . .	.42	12.10	3.49	.0757	.0465	.0294	.0171	1.31	–	–	.68	2.4
1916,[1] . . .	.41	12.34	3.92	.0539	.0336	.0257	.0079	1.28	–	–	.73	2.7

[1] October omitted.

Nashua River, at Pepperell.

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, . . .	.28	6.91	2.19	.0167	.0248	.0221	.0027	.78	.0137	.0008	.46	2.1
1901, . . .	.37	6.00	2.06	.0154	.0266	.0230	.0036	.45	.0092	.0005	.55	1.9
1902, . . .	.37	5.81	2.07	.0118	.0184	.0167	.0017	.49	.0162	.0006	.51	1.7
1903, . . .	.35	5.15	1.57	.0097	.0180	.0152	.0028	.44	.0128	.0008	.55	1.6
1904,[1] . . .	.30	6.23	1.93	.0111	.0206	.0171	.0035	.58	.0243	.0008	.44	1.9
1908, . . .	.32	10.85	3.40	.0317	.0295	.0202	.0093	1.45	.0194	.0008	.63	–
1909, . . .	.38	14.29	4.62	.0354	.0376	.0291	.0085	1.95	.0211	.0017	.92	–
1910, . . .	.37	14.77	4.14	.0128	.0329	.0252	.0077	1.93	.0207	.0008	.81	–
1911, . . .	.40	12.10	3.77	.0423	.0393	.0293	.0100	1.31	.0213	.0048	.62	–
1912,[2] . . .	.48	12.52	3.28	.0223	.0409	.0254	.0155	1.46	.0204	.0017	.75	–
1913,[3] . . .	.43	11.99	2.79	.0515	.0405	.0276	.0129	1.15	.0164	.0019	.73	–
1914,[4] . . .	.31	12.67	2.75	.0595	.0459	.0286	.0173	1.27	.0132	.0027	.59	–
1915, . . .	.46	8.25	2.27	.0222	.0328	.0237	.0091	.85	–	–	.63	–
1916,[1] . . .	.43	8.57	2.33	.0191	.0248	.0197	.0051	.78	–	–	.57	–

[1] Three months. [2] November omitted. [3] Four months. [4] Two months.

NEPONSET RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 290.

NEPONSET RIVER.

CHEMICAL EXAMINATION OF WATER FROM NEPONSET RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Neponset River, at Hyde Park.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
		Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Dissolved.	Albuminoid. Suspended.		Nitrates.	Nitrites.		
1887, ...	1.18	8.20	2.22	.0053	.0402	–	–	.98	.0077	–	–	–
1888, ...	1.12	7.77	2.37	.0040	.0392	.0358	.0034	1.08	.0074	.0003	–	–
1893, ...	1.27	8.60	2.68	.0233	.0370	.0282	.0088	1.47	.0045	.0009	1.00	2.6
1894, ...	1.19	12.87	3.03	.0196	.0466	.0333	.0133	2.31	.0033	.0002	1.03	4.1
1895, ...	.97	10.01	3.07	.0341	.0440	.0373	.0067	1.51	.0042	.0001	1.05	3.7
1896, ...	1.26	10.41	3.12	.0162	.0431	.0395	.0036	1.68	.0033	.0001	1.26	3.3
1897, ...	1.30	11.64	3.34	.0336	.0494	.0417	.0077	1.81	.0037	.0001	1.31	4.0
1898, ...	1.28	8.82	3.52	.0161	.0505	.0398	.0107	1.02	.0023	.0002	1.30	2.7
1899, ...	1.14	16.24	4.51	.0264	.0936	.0693	.0243	2.20	.0032	.0002	1.76	5.7
1900, ...	1.10	10.59	2.99	.0400	.0576	.0381	.0195	1.45	.0048	.0005	1.07	3.2
1901, ...	1.43	13.26	5.09	.0224	.0802	.0591	.0211	1.69	.0036	.0006	1.82	4.2
1902, ...	1.02	12.57	4.19	.0360	.0640	.0547	.0093	1.72	.0035	.0004	1.29	4.0
1903, ...	1.29	14.21	4.95	.0278	.0811	.0638	.0173	1.86	.0034	.0010	1.71	4.5
1904, ...	1.08	16.22	5.68	.0631	.1007	.0777	.0230	2.07	.0037	.0005	1.67	5.6
1905, ...	1.22	21.88	6.68	.0813	.1043	.0861	.0182	3.44	.0028	.0006	2.22	6.6
1906, ...	1.35	13.47	4.42	.0549	.0875	.0674	.0201	2.21	.0025	.0008	1.85	3.9
1907, ...	.90	22.58	6.31	.1201	.1412	.0961	.0451	3.81	.0042	.0004	1.94	6.9
1908, ...	–	25.40	7.19	.1132	.1209	.0844	.0365	5.08	.0027	.0006	2.01	8.8
1909, ...	–	28.69	9.08	.1723	.1218	.0898	.0320	5.35	.0027	.0009	2.02	10.0
1910, ...	–	31.37	10.16	.1740	.1333	.1000	.0333	5.84	.0010	.0002	2.96	10.4
1911, ...	1.24	18.82	5.49	.0786	.0727	.0539	.0188	3.36	.0025	.0007	1.86	7.1
1912, ...	.82	26.02	6.45	.1241	.1020	.0707	.0313	4.18	.0017	.0012	2.31	9.2
1913, ...	1.02	26.13	6.22	.0533	.0757	.0494	.0263	3.93	.0020	.0007	2.29	7.9
1914, ...	.93	20.27	4.37	.0754	.0697	.0484	.0213	3.43	.0025	.0008	1.31	5.2
1915,[1]	1.23	19.67	6.30	.0530	.1078	.0649	.0429	2.42	–	–	1.92	5.3
1916, ...	1.28	19.47	5.37	.0466	.0761	.0554	.0207	2.37	–	–	1.96	–

[1] Four months.

Quinebaug River.

A general statement of the condition of this river in the year 1916 will be found on page 291.

QUINEBAUG RIVER.

Chemical Examination of Water from Quinebaug River. — Averages for Six Months, from June to November, inclusive.

Quinebaug River, below Southbridge.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898, ...	.64	4.18	2.00	.0064	.0372	.0309	.0063	.18	.0050	.0003	.66	0.8
1899, ...	.44	4.32	1.72	.0071	.0298	.0229	.0069	.23	.0048	.0002	.54	1.2
1900, ...	.40	4.31	1.56	.0168	.0324	.0211	.0113	.25	.0024	.0003	.52	1.0
1901, ...	.42	4.52	1.67	.0147	.0232	.0158	.0074	.19	.0050	.0005	.45	1.7
1902, ...	.36	4.12	1.45	.0068	.0224	.0179	.0045	.24	.0054	.0002	.43	1.2
1903,[1]	.39	3.84	1.37	.0076	.0225	.0181	.0044	.24	.0043	.0002	.52	1.0
1904, ...	.40	4.17	1.57	.0086	.0247	.0189	.0058	.26	.0068	.0002	.53	1.2
1908, ...	.46	6.82	2.31	.0075	.0277	.0174	.0103	.33	.0038	.0003	.57	–
1909, ...	.40	5.48	1.99	.0087	.0275	.0219	.0056	.37	.0077	.0003	.56	–
1910, ...	.40	6.20	2.27	.0104	.0334	.0246	.0088	.42	.0032	.0004	.53	–
1911,[1]	.50	5.92	2.09	.0180	.0308	.0240	.0068	.41	.0067	.0002	.66	–
1912,[2]	.41	7.35	2.40	.0152	.0397	.0272	.0125	.52	.0025	.0004	.59	–
1913,[1]	.39	6.08	1.88	.0201	.0283	.0219	.0064	.59	.0075	.0007	.53	–
1914, ...	.52	11.93	2.36	.3033	.0514	.0323	.0191	2.41	.0078	.0052	.47	–
1915, ...	.68	7.56	2.49	.1499	.0457	.0327	.0130	.82	–	–	.91	–
1916, ...	.54	8.12	3.32	.0867	.0367	.0266	.0101	.52	–	–	.76	–

[1] Four months.

[2] Two months.

Taunton River.

A thorough examination of this stream and its tributaries was made in 1916, and the results of this examination are presented in detail on pages 313 to 331.

TAUNTON RIVER.

Chemical Examination of Water from Taunton River. — Averages for Six Months, from June to November, inclusive.

Taunton River, below Taunton.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1898,	1.56	6.64	3.30	.0109	.0345	.0314	.0031	.61	.0082	.0003	1.51	1.3
1899,	.93	6.31	2.48	.0176	.0317	.0279	.0038	.72	.0060	.0004	1.04	1.2
1900,	.71	6.89	1.91	.0205	.0286	.0258	.0028	1.06	.0112	.0006	.76	1.5
1901,	1.01	6.15	2.45	.0293	.0275	.0255	.0020	.76	.0134	.0005	.92	1.6
1902,[1]	.94	6.92	2.36	.1902	.0363	.0308	.0055	1.29	.0116	.0012	.90	1.4
1903,	.96	7.06	2.60	.0542	.0270	.0234	.0036	1.10	.0177	.0013	1.02	1.7
1904,	.95	6.49	2.60	.0855	.0319	.0264	.0055	.94	.0137	.0008	1.06	1.3
1906,[2]	1.41	7.37	3.11	.0401	.0385	.0331	.0054	.95	.0162	.0008	1.36	1.4
1907,[3]	.94	7.16	2.62	.1031	.0343	.0282	.0061	1.05	.0115	.0009	1.05	1.7
1908,	.73	7.66	2.52	.0469	.0278	.0226	.0052	1.31	.0108	.0011	.74	–
1909,	.90	12.97	3.87	.0416	.0303	.0263	.0040	3.49	.0105	.0014	.88	–
1910,	1.04	19.62	5.69	.0658	.0376	.0305	.0071	6.82	.0110	.0027	.93	–
1911,	1.04	9.65	2.80	.0385	.0330	.0270	.0060	1.73	.0205	.0015	1.04	–
1912,	1.17	10.35	2.95	.0461	.0366	.0295	.0071	1.76	.0173	.0015	1.03	–
1913,	1.09	18.58	4.24	.0506	.0377	.0334	.0043	5.94	.0130	.0015	1.07	–
1914,	.92	18.10	3.33	.0701	.0389	.0323	.0066	5.95	.0100	.0020	.88	–
1915,	1.35	9.38	3.38	.0469	.0465	.0374	.0091	1.24	–	–	1.34	–
1916,	1.70	9.58	3.72	.0323	.0424	.0341	.0083	1.20	–	–	1.74	–

[1] September omitted.

[2] June omitted.

[3] Four months.

TEN MILE RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 291.

TEN MILE RIVER.

CHEMICAL EXAMINATION OF WATER FROM TEN MILE RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Ten Mile River, below Attleboro.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS —		Oxygen consumed.	Hardness.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1899, ...	.71	6.39	2.15	.0072	.0379	.0288	.0091	.62	.0133	.0004	.74	1.7
1900, ...	.47	6.19	1.60	.0125	.0363	.0241	.0122	.84	.0155	.0004	.49	1.8
1901, ...	.46	6.09	2.12	.0084	.0290	.0202	.0088	.71	.0222	.0004	.51	1.8
1902, ...	.41	6.49	1.83	.0073	.0394	.0237	.0157	.88	.0212	.0004	.52	1.9
1903, ...	.36	7.48	2.39	.0282	.0346	.0200	.0146	.84	.0315	.0020	.53	1.8
1904, ...	.44	8.89	2.97	.0931	.0527	.0332	.0195	1.03	.0532	.0033	.58	3.5
1906,[1]	.48	17.57	6.45	.1586	.0914	.0490	.0424	1.07	.0638	.0121	.92	7.9
1907,[1]	.42	19.07	6.14	.6036	.1471	.0830	.0641	1.73	.2014	.0100	1.18	7.5
1908, ...	.40	10.89	3.27	.1108	.0483	.0294	.0189	1.37	.0364	.0035	.61	–
1909, ...	.47	11.23	2.88	.4322	.0626	.0380	.0246	1.51	.0263	.0086	.78	–
1910, ...	.29	12.05	3.32	.2422	.0545	.0330	.0215	1.98	.0357	.0051	.48	–
1911, ...	.76	11.94	3.58	.0604	.0506	.0302	.0204	1.55	.0382	.0036	.94	–
1912, ...	.39	28.98	11.42	.1056	.0750	.0287	.0463	1.92	.0368	.0075	.75	3.6
1913, ...	.64	13.55	3.33	.0951	.0630	.0303	.0327	1.90	.0242	.0069	.84	–
1914, ...	.51	15.32	3.09	.1909	.0673	.0401	.0272	1.73	.0300	.0087	.77	–
1915,[1]	.88	11.10	3.30	.0954	.0494	.0346	.0148	1.37	–	–	.98	3.2
1916, ...	–	13.23	3.42	.0912	.0510	.0340	.0170	1.66	–	–	.91	3.0

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[1] June omitted.

WESTFIELD RIVER.

A general statement of the condition of this river in the year 1916 will be found on page 291.

WESTFIELD RIVER.

CHEMICAL EXAMINATION OF WATER FROM WESTFIELD RIVER. — AVERAGES FOR SIX MONTHS, FROM JUNE TO NOVEMBER, INCLUSIVE.

Westfield River, below Westfield.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as —		Oxygen consumed.	Hardness.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1902, ...	.22	4.21	1.60	.0062	.0144	.0118	.0026	.14	.0062	.0002	.39	1.9
1903, ...	.15	3.68	1.30	.0037	.0127	.0105	.0022	.16	.0088	.0003	.28	1.8
1904, ...	.21	4.16	1.59	.0067	.0152	.0119	.0033	.16	.0068	.0001	.38	1.9
1906,[1]	.21	4.65	1.48	.0086	.0161	.0135	.0026	.18	.0035	.0003	.29	2.1
1907, ...	.24	4.49	1.63	.0053	.0137	.0111	.0026	.21	.0075	.0003	.31	2.0
1908, ...	.17	5.27	2.19	.0218	.0161	.0116	.0045	.27	.0063	.0006	.28	–
1909, ...	.22	5.56	1.68	.0179	.0187	.0143	.0044	.26	.0075	.0005	.34	–
1910, ...	.13	6.71	2.39	.0214	.0143	.0120	.0023	.30	.0304	.0010	.21	–
1911, ...	.25	5.86	2.03	.0272	.0162	.0133	.0029	.28	.0077	.0008	.38	–
1912,[2]	.13	6.40	2.08	.0286	.0189	.0130	.0059	.34	.0204	.0014	.24	–
1913, ...	.23	6.75	1.78	.0247	.0215	.0147	.0068	.30	.0292	.0012	.36	–
1914, ...	.15	6.50	1.72	.0255	.0255	.0161	.0094	.33	.0101	.0013	.26	–
1915, ...	.23	5.70	1.78	.0191	.0224	.0159	.0065	.27	–	–	.38	–
1916, ...	.25	6.58	2.62	.0258	.0183	.0139	.0044	.26	–	–	.39	–

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[1] Four months.

[2] September omitted.

EXAMINATION OF SEWAGE DISPOSAL WORKS.

The average results of the analyses of sewage and effluent, and statistics concerning the more important sewage disposal works in the State, are given in the following tables.

Very few improvements or additions have been made at the various disposal works during the year, the only exceptions being at Andover and Framingham. At Andover work has been in progress on the construction of an additional sludge bed with an area of .12 of an acre, and on the construction of four additional filter beds with an aggregate area of .37 of an acre; while at Framingham an addition of .37 of an acre was made to the filter beds, four of the beds were re-surfaced, and new underdrains laid in four others.

New filter beds at Pittsfield, partially constructed in 1915, were completed early in the year, thus making an aggregate filtration area of 41.15 acres, the second largest sand filtration works in Massachusetts. The analyses of the effluent from these filters show a falling off in efficiency as compared with the year 1915, but the comparatively poor results indicated by the averages for the year are due entirely to the overworked condition of the works early in the year before the recent additions were put into use.

The year has been a somewhat difficult one in the maintenance of filters on account of the excessive rainfall in the first six months. As a result of this and an increase in the number of sewer connections there has been a considerable increase in the quantity of sewage discharged at many of the works, especially at Andover, Clinton, Framingham, Gardner, Marlborough, Milford, Natick, Northbridge, North Attleborough and Westborough, with an accompanying falling off in the efficiency of the purification of the sewage at some of the works, especially at certain places where there has been a considerable increase in the quantity of factory wastes admitted to the sewers. There has also been a decrease in efficiency at some of the smaller plants not mentioned in the following tables; but notwithstanding the increase in the quantity of sewage and other adverse conditions, very few complaints due to odors or other objectionable conditions incident to the disposal of sewage have been made to this Department during the year.

TABLE No. 1. — *Average Results of the Analyses of Monthly Samples of Sewage as received at the Disposal Works, 1916 (Fats determined in about 66 Per Cent. of the Samples).*

[Parts in 100,000.]

CITY OR TOWN.	RESIDUE ON EVAPORATION.						AMMONIA.				Chlorine.	OXYGEN CONSUMED.		IRON.		Kjeldahl Nitrogen.	Fats.
	TOTAL RESIDUE.			LOSS ON IGNITION.				ALBUMINOID.									
	Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.	Free.	Total.	Dissolved.	Suspended.		Unfiltered.	Filtered.	Unfiltered.	Filtered.		
Amherst,[1]	34.60	28.47	6.13	15.37	10.30	5.07	2.12	.49	.35	.14	6.87	3.93	2.58	.089	.051	.94	3.57
Andover,	46.98	35.20	11.78	21.36	13.29	8.07	3.14	.71	.43	.28	9.18	5.31	2.92	.139	.056	1.28	6.90
ATTLEBORO,	52.55	39.77	12.78	25.12	14.82	10.30	4.54	.96	.66	.30	8.59	5.68	3.08	–	–	1.66	8.20
BROCKTON,[2]	95.48	55.90	39.58	54.95	19.20	35.75	4.69	1.49	.76	.73	13.33	15.78	8.48	.291	.089	2.67	10.41
Clinton,[3]	65.25	45.72	19.53	32.93	19.52	13.41	2.75	1.04	.62	.42	5.31	7.62	5.10	.161	.085	1.67	8.87
Concord,[1]	32.90	21.93	10.97	17.63	7.77	9.86	1.60	.46	.31	.15	3.97	3.90	1.91	–	–	.93	3.00
FITCHBURG,	51.62	31.70	19.92	25.10	12.33	12.77	1.96	.59	.39	.20	6.32	5.88	3.10	–	–	1.27	5.51
Framingham,	119.12	58.27	60.85	73.93	22.56	51.37	5.23	2.10	1.14	.96	10.68	16.68	8.54	.340	.065	3.50	29.85
Franklin,[1]	31.42	19.77	11.65	14.05	6.27	7.78	1.60	.45	.31	.14	3.03	1.72	1.05	–	–	.85	1.75
Gardner[4] (Gardner area),	208.30	66.20	142.10	165.40	38.65	126.75	8.14	5.72	1.52	4.20	7.07	32.22	8.02	.491	.065	11.36	26.53
Gardner (Templeton area),	76.75	54.30	22.45	41.37	22.68	18.69	9.55	1.74	1.23	.51	11.13	10.09	5.55	.205	.050	3.25	10.05
Hopedale,	71.58	42.22	29.36	37.44	16.36	21.08	7.19	1.26	.86	.40	7.85	10.19	5.99	–	–	2.28	6.80
Hudson,	137.03	92.88	44.15	60.72	27.05	33.67	5.43	2.11	1.32	.79	22.42	12.80	7.78	.166	.062	3.69	8.37
Leicester,[1]	40.23	28.67	11.56	18.40	11.67	6.73	2.73	.69	.44	.25	4.39	5.42	3.53	.191	.101	1.14	–
Marion,[1]	21.37	15.30	6.07	10.30	6.23	4.07	.97	.31	.17	.14	2.88	2.07	1.21	.107	.047	.71	5.05
MARLBOROUGH,	87.32	60.93	26.39	47.75	26.07	21.68	4.65	1.28	.74	.54	13.52	12.54	5.43	.183	.061	2.36	11.55
Milford,	70.52	48.18	22.34	35.87	17.85	18.02	4.11	.97	.57	.40	9.23	8.84	4.94	.210	.060	1.86	14.85
Natick,	47.82	38.65	9.17	19.03	11.67	7.36	3.04	.55	.36	.19	8.00	4.20	2.69	.208	.055	1.09	3.60
North Attleborough,[1]	24.77	18.67	6.10	11.37	6.17	5.20	.99	.41	.21	.20	3.33	2.36	1.22	.088	.042	.86	4.20
Northbridge,	47.37	31.72	15.65	23.77	11.90	11.87	3.60	.81	.56	.25	8.64	6.10	3.36	–	–	1.46	6.50
Norwood,	102.42	78.58	23.84	33.77	16.08	17.69	3.26	.84	.49	.35	22.55	10.47	6.25	.239	.084	1.85	8.19
PITTSFIELD,	42.05	30.58	11.47	19.78	9.90	9.88	2.09	.53	.32	.21	4.53	4.19	2.12	.109	.048	1.67	4.07
Southbridge,	68.58	41.08	27.50	40.67	16.53	24.14	6.71	1.53	.93	.60	7.75	9.77	5.21	.179	.057	2.72	6.60
Spencer,	37.53	25.85	11.68	21.11	10.74	10.37	2.76	.62	.41	.21	4.20	4.48	2.70	.097	.046	1.21	3.09
Stockbridge,[5]	32.36	26.00	6.36	14.04	9.16	4.88	.92	.21	.16	.05	2.28	2.43	1.09	–	–	.41	–
Westborough,	63.29	37.69	25.60	29.62	11.31	18.31	2.69	.80	.50	.30	9.92	6.70	3.45	.179	.054	1.54	6.30
WORCESTER (day),[6]	115.94	77.84	38.10	48.44	20.18	28.26	2.90	1.30	.55	.75	15.39	15.24	6.51	2.863	.751	2.53	7.65
WORCESTER (night),	106.60	77.53	29.07	46.11	25.27	20.84	1.64	.68	.23	.45	9.59	11.37	4.98	6.464	2.807	1.68	3.23

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[1] Every other month.
[2] May, June and October omitted.
[3] Outlet of tanks. Tanks not in use May to September, inclusive.
[4] Samples not taken carefully. January, February and November omitted.
[5] Five months.
[6] April, May and September omitted.

TABLE NO. 2. — *Average Results of the Analyses of Monthly Samples of Sewage as applied to Filter Beds after Preliminary Treatment as indicated (Fats determined in about 67 Per Cent. of the Samples).*

[Parts in 100,000.]

CITY OR TOWN.	Form of Preliminary Treatment.	RESIDUE ON EVAPORATION.						AMMONIA.				Chlorine.	OXYGEN CONSUMED.		IRON.		Kjeldahl Nitrogen.	Fats.
		TOTAL RESIDUE.			LOSS ON IGNITION.				ALBUMINOID.									
		Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.	Free.	Total.	Dissolved.	Suspended.		Unfiltered.	Filtered.	Unfiltered.	Filtered.		
Amherst,[1]	Tanks,	37.50	29.20	8.30	14.93	8.97	5.96	2.24	.51	.36	.15	7.44	3.95	2.77	.126	.053	.94	4.23
Andover,	Tank,	42.58	33.93	8.65	18.09	11.69	6.40	2.48	.50	.36	.14	7.87	4.26	2.86	.108	.053	.95	4.41
ATTLEBORO,	None,	52.55	39.77	12.78	25.12	14.82	10.30	4.54	.96	.66	.30	8.59	5.68	3.08	–	–	1.66	8.20
BROCKTON,[2]	Revolving screen,	80.20	51.95	28.25	41.38	17.05	24.33	5.48	1.17	.67	.50	12.55	12.04	6.79	.245	.083	2.32	8.38
Clinton,[3]	None,	65.25	45.72	19.53	32.93	19.52	13.41	2.75	1.04	.62	.42	5.31	7.62	5.10	.161	.085	1.67	8.87
Concord,[1]	None,	32.90	21.93	10.97	17.63	7.77	9.86	1.60	.46	.31	.15	3.97	3.90	1.91	–	–	.93	3.00
FITCHBURG,	Imhoff tanks,	41.85	33.65	8.20	19.40	14.52	4.88	2.15	.38	.28	.10	6.28	3.88	2.73	–	–	.88	3.32
Framingham,	None,	119.12	58.27	60.85	73.93	22.56	51.37	5.23	2.10	1.14	.96	10.68	16.68	8.54	.340	.065	3.50	29.85
Franklin,[1]	Tanks,	22.50	21.02	1.48	6.35	5.78	.57	1.48	.22	.18	.04	3.58	1.61	1.07	–	–	.33	1.78
Gardner[4] (Gardner area),	None,	208.30	66.20	142.10	165.40	38.65	126.75	8.14	5.72	1.52	4.20	7.07	32.22	8.02	.491	.065	11.36	26.53
Gardner (Templeton area),	Tanks,	40.24	31.08	9.16	19.80	12.43	7.37	4.16	.74	.48	.26	5.81	4.47	2.67	.109	.045	1.47	4.23
Hopedale,	Tanks,	41.11	33.89	7.22	19.49	13.85	5.64	5.31	.74	.54	.20	6.60	5.32	3.33	–	–	1.37	5.43
Hudson,	Tanks,	76.28	63.62	12.66	29.30	20.02	9.28	4.40	.95	.71	.24	13.71	6.08	4.32	.105	.046	1.75	2.75
Leicester,[1]	Tanks,	28.12	24.43	3.69	11.66	9.14	2.52	2.58	.43	.30	.13	3.86	3.37	2.75	.156	.060	.94	–
Marion,[1]	None,	21.37	15.30	6.07	10.30	6.23	4.07	.97	.31	.17	.14	2.88	2.07	1.21	.107	.047	.71	5.05
MARLBOROUGH,	Tanks,	54.36	46.56	7.80	25.07	18.83	6.24	4.68	.78	.56	.22	9.51	6.90	4.02	.161	.069	1.50	5.20
Milford,	Tanks,	53.15	43.91	9.24	22.07	14.91	7.16	3.77	.66	.46	.20	8.15	4.71	3.37	.149	.059	1.31	7.85
Natick,	None,	47.82	38.65	9.17	19.03	11.67	7.36	3.04	.55	.36	.19	8.00	4.20	2.69	.208	.055	1.09	3.60
North Attleborough,[1]	Tanks,	21.12	18.83	2.29	6.64	5.63	1.01	.88	.19	.13	.06	3.47	1.40	.94	.069	.043	.35	2.25
Northbridge,	Tanks,	25.07	18.87	6.20	12.67	8.00	4.67	3.11	.47	.34	.13	4.08	2.97	1.98	–	–	.91	2.25
Norwood,	Tank,	64.73	54.03	10.70	21.33	12.78	8.55	2.33	.44	.28	.16	17.83	5.28	3.58	.355	.089	.96	2.84
PITTSFIELD,	None,	42.05	30.58	11.47	19.78	9.90	9.88	2.09	.53	.32	.21	4.53	4.19	2.12	.109	.048	1.07	4.07
Southbridge,	Tanks,	35.43	30.53	4.90	14.97	11.37	3.60	3.24	.51	.39	.12	6.08	4.20	3.01	.132	.073	.95	6.25
Spencer,	None,	37.53	25.85	11.68	21.11	10.74	10.37	2.76	.62	.41	.21	4.20	4.48	2.70	.097	.046	1.21	3.09
Stockbridge,[5]	None,	32.36	26.00	6.36	14.04	9.16	4.88	.92	.21	.16	.05	2.28	2.43	1.09	–	–	.41	–
Westborough,	None,	63.29	37.69	25.60	29.62	11.31	18.31	2.69	.80	.50	.30	9.92	6.70	3.45	.179	.054	1.54	6.30
WORCESTER (day),[6]	None,	115.94	77.84	38.10	48.44	20.18	28.26	2.90	1.30	.55	.75	15.39	15.24	6.51	2.863	.751	2.53	7.65

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[1] Every other month.

[2] December, May, June and October omitted.

[3] Outlet of tanks. Tanks not in use May to September, inclusive.

[4] Samples not taken carefully. January, February and November omitted.

[5] Five months.

[6] April, May and September omitted.

TABLE NO. 3. — *Efficiency of Settling Tanks and Other Forms of Preliminary Treatment as indicated by the Foregoing Tables.*

[Parts in 100,000.]

CITY OR TOWN.	Form of Preliminary Treatment.	SUSPENDED SOLIDS.			TOTAL ALBUMINOID AMMONIA.			OXYGEN CONSUMED.			FATS.[1]			CHLORINE.		Approximate Period of Sedimentation, assuming Tanks contain no Deposits (Hours).	Frequency of Cleaning Tanks.
		Raw Sewage.	Settled or Treated Sewage.	Per Cent. removed.	Raw Sewage.	Settled or Treated Sewage.	Per Cent. removed.	Raw Sewage.	Settled or Treated Sewage.	Per Cent. removed.	Raw Sewage.	Settled or Treated Sewage.	Per Cent. removed.	Raw Sewage.	Settled or Treated Sewage.		
Amherst,[2] . . .	Tanks, . . .	6.13	8.30	–	.49	.51	–	3.93	3.95	–	3.57	4.23	–	6.87	7.44	–[3]	– – –
Andover, . . .	Tank, ...	11.78	8.65	27	.71	.50	30	5.31	4.26	20	6.90	4.41	36	9.18	7.87	½–1¾	Once in two to four weeks.
BROCKTON, . . .	Revolving screen, .	39.58	28.25	29	1.49	1.17	21	15.78	12.04	24	10.41	8.38	19	13.33	12.55	–	– – –
FITCHBURG, . .	Imhoff tanks,[4] .	19.92	8.20	59	.59	.38	36	5.88	3.88	34	5.51	3.32	40	6.32	6.28	2–10	Six times during year.
Franklin,[2] . . .	Tanks, . . .	11.65	1.48	87	.45	.22	51	1.72	1.61	6	1.75	1.78	–	3.03	3.58	6½–7½	Fifteen times during year.
Gardner (Templeton area).	Tanks, . . .	22.45	9.16	59	1.74	.74	57	10.09	4.47	56	10.05	4.23	58	11.13	5.81	5½–7¼	– – –
Hopedale, . . .	Tanks, . . .	29.36	7.22	75	1.26	.74	41	10.19	5.32	48	6.80	5.43	20	7.85	6.60	19–38	Yearly.
Hudson, . . .	Tanks, . . .	44.15	12.66	71	2.11	.95	55	12.80	6.08	52	8.37	2.75	67	22.42	13.71	13–25	Yearly.
Leicester,[2] . . .	Tanks, . . .	11.56	3.69	68	.69	.43	38	5.42	3.37	38	–	–	–	4.39	3.86	–	Fourteen times during year.
MARLBOROUGH, .	Tanks, . . .	26.39	7.80	70	1.28	.78	39	12.54	6.90	45	11.55	5.20	55	13.52	9.51	–[5]	Twelve times during year.
Milford, . . .	Tanks, . . .	22.34	9.24	59	.97	.66	32	8.84	4.71	47	14.85	7.85	47	9.23	8.15	3¼–4¾	– – –
North Attleborough,[2]	Tanks, . . .	6.10	2.29	62	.41	.19	54	2.36	1.40	41	4.20	2.25	46	3.33	3.47	3–4	Yearly.
Northbridge, . .	Tanks, . . .	15.65	6.20	60	.81	.47	42	6.10	2.97	51	6.50	2.25	65	8.64	4.08	¾–1¾	– – –
Norwood, . . .	Tank, ...	23.84	10.70	55	.84	.44	48	10.47	5.28	50	8.19	2.84	65	22.55	17.83	–	Six times during year.
Southbridge, . .	Tanks, . . .	27.50	4.90	82	1.53	.51	67	9.77	4.20	57	6.60	6.25	5	7.75	6.08	3½–8¾	Ten times during year.
WORCESTER, . .	Chemical precipitation.	29.07	8.34	71	.68	.32	53	11.37	4.03	66	3.23	4.15	–	9.59	8.17	–	– – –

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[1] Fats determined in about two-thirds of the samples.

[2] Samples collected every other month.

[3] Very short period.

[4] Five tanks. Flow reversed five times.

[5] Several compartments. Operated so as to get good sedimentation, but not to produce a septic effluent.

TABLE NO. 4. — *Average Results of the Analyses of Monthly Samples of Sewage applied to the Trickling Filters at Brockton and Fitchburg, and of their Effluents, etc. Per Cents. removed, etc.*

Brockton.

[Parts in 100,000.]

	RESIDUE ON EVAPORATION.						AMMONIA.					NITROGEN AS —		OXYGEN CONSUMED.				
	TOTAL RESIDUE.			LOSS ON IGNITION.				ALBUMINOID.										
	Total.	Dissolved.	Suspended.	Total.	Dissolved.	Suspended.	Free.	Total.	Dissolved.	Suspended.	Chlorine.	Nitrates.	Nitrites.	Unfiltered.	Filtered.	Kjeldahl Nitrogen.	Fats.	Remarks.
Screened sewage as applied to trickling filter.	77.10	55.36	21.74	36.00	19.90	16.10	6.65	1.34	.81	.53	13.07	–	–	10.28	5.72	2.55	6.77	The trickling filter has an area of .5 of an acre and a depth of 5.5 to 6.5 feet of crushed stone from 1.5 to 3 inches in size. The average rate of operation was 1,319,000 gallons per acre per day.
Effluent from trickling filter,	66.14	49.56	16.58	30.07	16.71	13.36	4.07	.93	.52	.41	11.69	.9044	.0140	7.68	3.48	1.80	2.62	
Per cent. removed,	14	–	24	16	–	17	39	31	–	23	–	–	–	25	39	29	61	
Settled effluent from trickling filter as applied to sand filters.	53.22	45.50	7.72	21.08	15.04	6.04	3.78	.60	.36	.24	12.10	.6541	.0840	5.70	3.42	1.18	2.22	Period of sedimentation three and one-quarter to eight hours. Tank cleaned monthly.
Per cent. removed,	20	–	54	30	–	55	7	35	–	41	–	–	–	26	2	34	15	
Per cent. removed by trickling filter and settling tank.	31	–	65	41	–	63	43	55	–	55	–	–	–	45	40	54	67	

Fitchburg.

Inhoff tank effluent as applied to trickling filter.	41.85	33.65	8.20	19.40	14.52	4.88	2.15	.38	.28	.10	6.28	–	–	3.88	2.73	–	3.32	The trickling filter has an area of 2.14 acres and a depth of 10 feet of stone from 1 to 3 inches in size. The average rate of operation was about 1,399,200 gallons per acre per day.
Effluent from trickling filter,	37.85	29.98	7.87	16.35	10.78	5.57	.59	.19	.12	.07	6.22	.9303	.0127	1.91	1.20	–	1.91	
Per cent. removed, . .	10	–	4	16	–	–	73	50	–	33	–	–	–	51	56	–	42	
Settled effluent from trickling filter as discharged to Nashua River.	37.34	33.64	3.70	17.21	15.12	2.09	.70	.16	.11	.05	6.21	.9571	.0110	1.62	1.23	–	1.69	Period of sedimentation averaged about one and three-quarters hours. The tanks were cleaned eight times during the year.
Per cent. removed, . .	1	–	53	–	–	62	–	16	–	29	–	–	–	15	–	–	12	
Per cent. removed by trickling filter and settling tanks.	11	–	55	11	–	57	67	58	–	50	–	–	–	58	55	–	49	

Table No. 5. — *Average Results of the Analyses of Monthly Samples of Effluent from Sand Filters.*

[Parts in 100,000.]

City or Town.	Total Residue on Evaporation.	Free Ammonia.	Total Albuminoid Ammonia.	Chlorine.	Nitrogen as —		Iron.
					Nitrates.	Nitrites.	
Amherst,[1]	23.12	1.33	.0639	4.64	.0993	.0053	1.483
Andover,[2]	26.63	1.04	.1308	7.07	.3690	.0239	.261
Brockton[2] (sand filters used for screened sewage).	42.45	3.91	.1338	12.12	.0507	.0023	1.602
Brockton[3] (sand filters used for settled trickling filter effluent).	41.29	1.92	.0907	11.84	.2589	.0076	.598
Clinton,[2]	26.84	.87	.0897	4.97	.3829	.0086	.880
Concord,[1]	18.34	.32	.0150	4.14	.3812	.0110	.011
Framingham,[2]	37.59	2.12	.1016	8.59	.1480	.0084	2.053
Franklin,[1, 3]	20.64	.17	.0140	3.26	.7853	.0019	.011
Gardner (Gardner area),	35.41	1.22	.1180	5.96	1.9107	.0068	.045
Gardner (Templeton area),[2]	33.79	1.80	.1726	6.17	1.1556	.0396	.121
Hopedale,[2]	33.01	1.62	.1365	5.96	1.5829	.0864	.039
Hudson,	57.57	1.16	.1178	13.86	1.3392	.0358	.225
Leicester,[1]	20.32	.51	.0801	3.89	.8621	.0169	.121
Marion,[1]	15.48	.40	.0402	3.87	.2303	.0016	.057
Marlborough,[2]	36.89	.49	.0378	7.37	1.5536	.0065	.031
Milford,	29.83	.84	.0583	7.58	1.0350	.0178	.219
Natick,[4]	25.60	1.90	.0663	7.83	.2516	.0083	1.017
North Attleborough,[1]	20.68	.03	.0108	3.16	.5127	.0015	.010
Northbridge,[3]	17.40	.85	.0769	3.73	.2468	.0194	.525
Norwood,	40.88	1.11	.0539	15.90	.1849	.0149	.700
Pittsfield,[2]	38.71	1.17	.1491	5.05	.3059	.0147	.690
Southbridge,[2]	25.38	2.25	.0712	6.01	.0392	.0012	1.813
Spencer,[3]	16.70	.21	.0304	3.33	.5531	.0112	.092
Stockbridge,[5]	25.54	.21	.0465	2.58	.3435	.0224	.090
Westborough,[2]	25.63	.89	.1057	7.96	.3725	.0219	.683
Worcester,[6]	59.83	1.72	.1222	13.95	.4519	.0201	1.367

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[1] Every other month.
[2] Regular samples from two or more underdrains combined in one average.
[3] Single sample at each examination made up of equal parts from two or more underdrains.
[4] December, February, April and July omitted.
[5] Seven samples from each underdrain combined in one average.
[6] April, May, September and October omitted.

Note. — Attleboro effluent omitted. Very little effluent has as yet been collected in the underdrains. Concord filters not underdrained, but purified sewage forms a spring from which the samples, represented by the above analysis, were collected.

TABLE NO. 6. — *Efficiency of Sand Filters (Per Cents. of Free and Albuminoid Ammonia removed).*

CITY OR TOWN.	FREE AMMONIA.			TOTAL ALBUMINOID AMMONIA.			CHLORINE.		Rate of Operation with Even Distribution (Gallons per Acre per Day).[1]
	Applied Sewage.	Effluent.	Per Cent. removed.	Applied Sewage.	Effluent.	Per Cent. removed.	Applied Sewage.	Effluent.	
Amherst,	2.24	1.33	41	.51	.0630	88	7.44	4.64	–
Andover,	2.48	1.04	58	.50	.1308	74	7.87	7.07	81,000
BROCKTON (filters for screened sewage),	5.48	3.91	29	1.17	.1338	89	12.55	12.12	47,000
BROCKTON (filters for settled trickling filter effluent).	3.78	1.92	49	.60	.0907	85	12.10	11.84	94,000
Clinton,	2.75	.87	68	1.04	.0897	91	5.31	4.97	47,000
Concord,[2]	1.60	.32	80	.46	.0150	97	3.97	4.14	121,000
Framingham,	5.23	2.12	59	2.10	.1016	95	10.68	8.59	39,000
Franklin,	1.48	.17	89	.22	.0140	94	3.58	3.26	45,000
Gardner (Gardner area),[3]	8.14	1.22	85	5.72	.1180	98	7.07	5.96	66,000
Gardner (Templeton area),	4.16	1.80	57	.74	.1726	77	5.81	6.17	66,000
Hopedale,	5.31	1.62	70	.74	.1365	82	6.60	5.96	31,000
Hudson,	4.40	1.16	74	.95	.1178	88	13.71	13.86	38,000
Leicester,	2.58	.51	80	.43	.0801	81	3.86	3.89	195,000
Marion,	.97	.40	59	.31	.0402	87	2.88	3.87	190,000
MARLBOROUGH,	4.68	.49	90	.78	.0378	95	9.51	7.37	43,000
Milford,	3.77	.84	78	.66	.0583	91	8.15	7.58	54,000
Natick,	3.04	1.90	38	.55	.0663	88	8.00	7.83	76,000
North Attleborough,	.88	.03	97	.19	.0108	94	3.47	3.16	96,000
Northbridge,	3.11	.85	73	.47	.0769	84	4.08	3.73	78,000
Norwood,	2.33	1.11	52	.44	.0539	88	17.83	15.90	–
PITTSFIELD,	2.09	1.17	44	.53	.1491	72	4.53	5.05	83,000
Southbridge,	3.24	2.25	31	.51	.0712	86	6.08	6.01	101,000
Spencer,	2.76	.21	92	.62	.0304	95	4.20	3.33	48,000
Stockbridge,	.92	.21	77	.21	.0465	78	2.28	2.58	–
Westborough,	2.69	.89	67	.80	.1057	87	9.92	7.96	78,000
WORCESTER,	2.90	1.72	41	1.30	.1222	91	15.39	13.95	61,000

[1] See also Table No. 7.

[2] See note at foot of Table No. 5.

[3] These filters given long periods of rest when necessary.

TABLE NO. 7. — *Extent of Sewerage Works, Rate of Flow and Rate of Operation of Sand Filters, etc.*

CITY OR TOWN.	Population, Census of 1915.	Approximate Length of Sanitary Sewers (Miles).	Approximate Number of House Connections.	ESTIMATED QUANTITY OF SEWAGE TREATED (GALLONS PER DAY).			Estimated Average Quantity of Sewage per Connection (Gallons per Day).	Net Area of Filter Beds.	Estimated Rate of Operation with Even Distribution (Gallons per Acre per Day).
				Average for Year.	Average for Month of Maximum Flow.	Average for Month of Minimum Flow.			
Andover,	7,978	12.32	766	296,000	542,000	120,000	386	3.65[1]	81,000
ATTLEBORO,	18,480	30.86	933	511,000	663,000	354,000	550	15.50	33,000
BROCKTON: —									
Filters for screened sewage,	62,288	–	–	1,405,500[2]	1,812,000	1,043,000	–	30.00	47,000
Filters for settled trickling filter effluent,				659,500[2]	980,500	525,000	–	7.00	94,000
Clinton,	13,192	–	–	1,226,000[2]	2,199,000	765,000	–	26.23	47,000
Concord,	6,681	8.55	456	399,000[2]	491,000	318,000	875	3.30	121,000
FITCHBURG,	39,656	54.26	–	3,025,000	–	–	–	–	–
Framingham,	15,860	25.04	2,217	830,000[2]	1,250,000	622,000	374	21.12[3]	39,000
Franklin,	6,440	11.27	233	146,500	–	–	629	3.24	45,000
Gardner,	16,376	28.05	1,746	825,000	–	–	470	12.50[4]	66,000
Hopedale,	2,663	5.10	279	116,000[2]	175,000	79,000	416	3.79	31,000
Hudson,	6,758	9.37	571	346,000	553,000	215,000	606	9.00	38,000
Leicester,	3,322	–	–	70,000	–	–	–	.36	194,000
Marion,	1,487	–	137	125,000[2]	180,000	60,000	913	.66	190,000
MARLBOROUGH,	15,250	27.70	1,991	902,000	1,988,000	377,000	450	20.90	43,000
Milford,	13,684	17.53	1,176	506,000	676,000	346,000	430	9.30	54,000
Natick,	11,119	15.44	1,358	954,000[2]	1,830,000	443,000	700	12.60	76,000
North Attleborough,	9,398	16.13	491	675,000	750,000	586,000	1,375	7.00	96,000
Northbridge,	9,254	–	–	468,000	535,000	402,000	–	6.00	78,000
Norwood,	10,977	–	–	–	–	–	–	8.60[5]	–
PITTSFIELD,	39,607	58.64	4,545	3,426,000[2]	3,988,000	2,727,000	755	41.15	83,000
Southbridge,	14,217	15.89	1,059	857,000	1,012,000	707,000	810	8.50	101,000
Spencer,	5,994	–	–	450,000	–	–	–	9.30	48,000
Westborough,	5,925	9.53	545	450,000	794,000	285,000	825	5.80	78,000
WORCESTER,	162,697	178.32[6]	–	4,438,000[7]	–	–	–	72.60	61,000

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[1] A sludge bed with an area of .12 of an acre and four filter beds with an aggregate area of .37 of an acre under construction.

[2] From pumping records.

[3] There was .37 of an acre added during year. Four beds resurfaced. New underdrains laid in four beds.

[4] Gardner area, 2.50 acres. Templeton area, 10 acres.

[5] Two new beds with an aggregate area of 1.94 acres laid out but not ready for use.

[6] Includes 69.49 miles of combined sewers.

[7] Amount treated by sand filters. An average of 16,035,000 gallons per day treated by chemical precipitation.

TABLE No. 8. — *General Features.*

[For data concerning the trickling filters at Brockton and Fitchburg see Table No. 4.]

CITY OR TOWN.	Year of Construction of and Additions to Works.	Depth of Underdrains (Feet).	Distance Apart of Underdrains (Feet).	Filtering Material.	Attention given to Disposal Works.
Amherst,	1911	4-4.5	25	Rather fine sand; found in place,	Very little attention.
Andover,	1898	4	20	Fair sand, small quantity of gravel; practically all handled in construction.	One man greater part of time.
ATTLEBORO,	1912, 1913	4-7	35	Excellent sand and gravel; found in place,	One man all the time; others when necessary.
BROCKTON,	1893, 1905 1908, 1912	5.5	30	Good sand and gravel; found in place,	Four men all the time; large force when necessary.
Clinton,	1898, 1899	8	60-70	Good sand and gravel; found in place,	Two men all the time; others when necessary.
Concord,	1899	none	–	Good sand underlaid with gravel; found in place,	One man once a day.
Framingham,	1890	–[1]	–	Surface material badly impregnated with organic matter; good underlying sand. Beds prepared by removal of trees and stumps and leveling where necessary.	Three or more men in summer; only one once a day in winter.
Franklin,	1915	4.5	26	Good sand and gravel,	One man every two or three days; others when necessary.
Gardner (Gardner area),	1891	5	20	Good sand; handled in construction,	One man all the time.
Gardner (Templeton area),	1901, 1909	3-4	20-30	Coarse sand; handled in construction,	One man all the time; more when necessary.
Hopedale,	1900	3	35-60	Some good sand and some rather fine sand,	One man all the time.
Hudson,	1904, 1910	5-6	50-100	Good sand and gravel; found in place,	One man all the time; others when necessary.
Leicester,	1894	4	8	Hard, compact sand; found in place,	Very little attention.
Marion,	1906	5	–	Mostly good sand; pockets of fine sand and some ledge; largely found in place.	One man every day in summer; every other day in winter.
MARLBOROUGH,	1891, 1908 1909, 1910, 1911	4.5-6	30-50	Rather fine sand; found in place,	One man all the time; others when necessary.
Milford,	1907	5	40	Rather fine sand; found in place,	One man every day; others when necessary.
Natick,	1896	6	36	Sand of good quality, but strata of very fine sand in places; found in place.	One man all the time; others when necessary.
North Attleborough,	1909, 1910	5-6.5	55	Coarse sand and gravel; largely found in place,	One man every day; others when necessary.
Northbridge,	1906, 1907	4	50-75	Coarse sand and gravel; found in place,	One man all the time; others when necessary.
Norwood,	1909	4-6	40	Good sand and gravel; found in place,	One man every day; others when necessary.
PITTSFIELD,	1901, 1915	4	35	Good sand; mostly found in place,	Two men all the time; others when necessary.
Southbridge,	1908	4	40	Fair sand and gravel; considerable quantity handled, some found in place.	One man once a day.
Spencer,	1897	–[2]	–	Good sand and gravel; largely found in place,	One man all the time; others when necessary.
Stockbridge,	1899	3-4.5 3-4.5	23 30	Sand filters, good quality sand, Irrigation area, rather fine sand,	One man greater part of time.
Westborough,	1892, 1911	5	30-40	Good sand and gravel; handled during construction,	One man all the time; others when necessary.
WORCESTER,	1898[3]	4-6	35-50	Good sand and gravel; largely found in place,	Several men all the time; a large force when necessary.

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[1] Very little underdrainage in 8 beds. Fifteen out of 20 beds provided with underdrains 4 to 6 feet deep and about 40 feet apart.

[2] Only 3 beds underdrained.

[3] Year of first construction of sand filters. Many additions.

DIVISION OF WATER AND SEWAGE LABORATORIES.

H. W. CLARK, *Director and Chief Chemist.*

REPORT OF THE DIVISION OF WATER AND SEWAGE LABORATORIES.

The work of the Division of Water and Sewage Laboratories is carried on very largely in laboratories in the State House and at the experiment station and its laboratories at Lawrence. The Division does all of the analytical and much of the investigating work demanded by the provisions of the act entitled "An Act to protect the Purity of Inland Waters of the State." Investigations and analytical work, including chemical, bacteriological and microscopical work, are called for by many special acts having to do with public welfare and public health as related to water supply, sewerage, condition of rivers, etc.

In carrying out this work, which involves the examination of the waters of all the public water supplies in the State, of the rivers at different points, of the sewage applied to and the effluents from the sewage disposal areas of the State, and of the wastes from factories, together with many samples of effluent from purification works at these factories, etc., there have been examined in the State House laboratories during 1916, 6,472 samples of water, sewage, etc., divided approximately as shown below: —

Samples from public water supplies: —	
Surface waters,	2,065
Ground waters,	1,069
Samples from rivers,	1,508
Samples from sewage-disposal works, sewer outlets, etc.: —	
Sewage,	632
Filter effluents,	682
Samples of wastes from factories,	300
Sea waters and miscellaneous samples,	216
Total,	6,472

Figures and tables giving the results of much of this analytical work will be found in an appendix.

At the experiment station 2,859 samples were examined in carrying out work which may be generalized as follows: —

Trade wastes and their treatment, filtration and other treatment of water supplies, etc.,	1,179
Samples examined on account of investigations concerning the disposal of domestic sewage, etc.,	1,680
Total,	2,859

In addition, the Division has made about 900 special determinations, including those of fatty matters in sewage, manganese in ground waters, and lead and copper in drinking waters. Considerable field work involving determinations of carbonic acid, dissolved oxygen, etc., in polluted rivers, water supplies, etc., has been carried on.

The bacteriological work of the Department has called for the examination of 4,153 samples by this Division, 2,200 of these being from water supplies and the remainder from rivers or samples, examination of which was necessary on account of investigations of shellfish from Boston Harbor and elsewhere in the State, disinfection of shellfish, and testing the efficiency of double check valves between fire supplies and public water supplies at mills, etc.

Two hundred and fifty-two samples of sand have been examined either mechanically or chemically, or both, in connection with studies of municipal sewage and water filters about to be constructed or already in operation in the State.

In the microscopical laboratory of this Division 1,862 samples have been examined, and the biologist has spent considerable time in field work, in studies of organisms of more or less account in the activated sludge and similar processes, etc.

Special studies have been made on the following subjects: —

1. Purification of sewage by aeration and activation.
2. The oxidation and stabilization of sewage sludge by treatment with nitrates either as filter effluents or added nitrate salts.
3. Stabilization of sludge by aeration.
4. Relation between depth of filter, filter material and filter efficiency in trickling filter purification.
5. Treatment of trade wastes by the activated sludge method.
6. Special studies in regard to the Merrimac Chemical Company's wastes and the condition of the Aberjona River and Mystic lakes.
7. Studies of tanneries and tannery wastes in connection with anthrax among tannery employees.
8. Studies of radioactivity of water.
9. Determinations of acidity and alkalinity of water by the potentiometer.

10. Investigations of the efficiency of double check valve systems between mill fire supplies and public water supplies.

11. Studies of the removal of color from different classes of water.

12. Studies of the changes in water induced by treatment with chemicals as a preliminary to mechanical filtration.

13. Condition of clams from flats in Boston Harbor and vicinity. About 1,000 clams were examined from 309 stations.

14. Disinfection of clams and oysters with hypochlorite.

15. Work in regard to reconstruction of a portion of the municipal filter at Lawrence.

Thirteen reports were made to the Engineering Division during the year covering some of the work outlined above as well as other work not mentioned here. Much of the work of the Division of Water and Sewage Laboratories appears only in reports of the Department's Division of Engineering and in replies to applications for advice from cities and towns. Many of the special subjects investigated, however, are summarized in a subsequent portion of this report.

The Treatment of Clams with Hypochlorite.

The following tables present the results of experiments made at Lawrence to determine the efficiency of calcium hypochlorite in the disinfection of clams. In these experiments from fifteen to forty clams were placed in water containing a large number of sewage bacteria, and then in water containing varying amounts of calcium hypochlorite. The strength of the hypochlorite solutions ranged from as low as 5 parts per 1,000,000 free chlorine to 1.7 per cent. free chlorine, or 17,000 parts per 1,000,000. The time elapsing before examination was either one, two, three, six, twenty-four or forty-eight hours, as shown on the tables.

The experiments show that no marked reduction in the bacterial content of the clam was obtained until a solution containing .8 per cent. of free chlorine was used. In this experiment there was a removal of 82 per cent. of the bacteria shown by the 20° C. count; 99.7 per cent. of the total bacteria and 100 per cent. of the red colonies grown at 37° C.

Experiment No. 1.

Fifteen clams in the shell were placed in earthenware dishes containing hypochlorite solutions of increasing strength; that is, from 5 to 25 parts per 1,000,000 free chlorine, respectively. Five of the clams were taken from the solutions at the end of one hour, five at the end of six hours and five after twenty-four hours' immersion, and examined immediately. All work was done according to standard methods of shellfish examination. Examinations of the clams as received were made, and a control was run in each case by immersing clams in sterilized sea water or equivalent salt solution.

The following table presents the results of this work. The solutions used in this experiment were not sufficiently strong to materially affect the 20° C. count, and only slightly affected the 37° C. count, and the acid-forming bacteria were not reduced as was expected. In this experiment immersion for one hour was practically as effective as immersion for six and twenty-four hours.

Bacterial Analyses of the Average Shell-water from Five Clams.

Elapsed Time, One Hour.

	Free Chlorine (Parts per Million).	Bacteria per Cubic Centimeter.			B. Coli.			
		4 Days, 20° C.	24 hours, 37° C.		.001 Cubic Centimeter.	.01 Cubic Centimeter.	0.1 Cubic Centimeter.	1.0 Cubic Centimeter.
			Total.	Red.				
Untreated clam,	-	4,000	740	70	0	0	0	+
Control,	-	16,000	660	50	0	0	+	+
	5[1]	4,600	420	40	0	0	+	+
	10[1]	3,800	530	20	0	0	0	+
	15[1]	4,500	460	10	0	0	0	+
	20[1]	10,000	290	70	0	0	+	+
	25[1]	9,000	130	10	0	0	0	+
Elapsed Time, Six Hours.								
Control,	-	11,000	560	160	0	0	0	+
	5[1]	2,000	760	10	0	0	0	+
	10[1]	2,700	720	30	0	0	0	+
	15[1]	2,400	147	42	0	0	0	+
	20[1]	2,200	460	10	0	0	0	+
	25[1]	6,000	870	10	0	0	+	+
Elapsed Time, Twenty-four Hours.								
Control,	-	13,000	2,000	900	0	0	+	+
	5[1]	22,400	1,100	100	0	0	+	+
	10[1]	2,700	620	70	0	0	0	+
	15[1]	4,900	1,200	140	0	0	0	+
	20[1]	6,000	1,400	170	0	0	+	+
	25[1]	2,100	1,200	200	0	0	0	+

[1] Free chlorine present at the end of the experiment.

Experiment No. 2.

Clams as received from the market were immersed in agate dishes containing hypochlorite solutions with a strength of from 10 to 70 parts per million. After periods of three, twenty-four and forty-eight hours, five clams were taken from each dish for examination. As before, examinations of the clams as received and after immersion in salt solution were made as controls.

It was assumed in this work that when the clams were immersed in comparatively weak bleaching powder solutions they would allow a sufficient volume of the solution to enter their shells to cause sterilization. The results were disappointing, however. Again the bacterial counts were not as low as expected, and the acid-forming bacteria were not reduced. After twenty-four hours, however, B. coli were not found in .01 of a cubic centimeter. Either the clams did not allow any of the solution to enter, or the small quantity taken was rapidly exhausted by mucous matter, dirt, etc., within the shells, and hence did not attack the bacteria. Tests for free chlorine were made after these immersions in the average shell-water of five clams, but none was found. Free chlorine, however, was present in the solutions during the entire period of the tests, including the twenty-four hour period.

The following table gives the results of this experiment: —

Bacterial Analyses of the Average Shell-water from Five Clams.

Elapsed Time, Three Hours.

	Free Chlorine (Parts per Million).	Bacteria per Cubic Centimeter.			B. Coli.			
		4 Days, 20° C.	24 hours, 37° C.		.001 Cubic Centimeter.	.01 Cubic Centimeter.	0.1 Cubic Centimeter.	1.0 Cubic Centimeter.
			Total.	Red.				
Untreated clam,	–	16,000	12,500	4,600	+	+	+	+
Control,	–	1,800	520	180	0	+	+	+
	10[1]	4,000	200	70	0	0	+	+
	20[1]	36,000	610	260	0	+	+	+
	30[1]	3,600	590	180	0	+	+	+
	40[1]	9,700	1,500	580	0	+	+	+
	50[1]	9,000	680	210	0	+	+	+
	60[1]	1,600	310	60	0	0	+	+
	70[1]	15,000	780	300	0	+	+	+

[1] Free chlorine present at the end of the experiment.

Bacterial Analyses of the Average Shell-water from Five Clams — Concluded.

Elapsed Time, Twenty-four Hours.

	Free Chlorine (Parts per Million).	Bacteria per Cubic Centimeter.			B. Coli.			
		4 Days, 20° C.	24 hours, 37° C.		.001 Cubic Centimeter.	.01 Cubic Centimeter.	0.1 Cubic Centimeter.	1.0 Cubic Centimeter.
			Total.	Red.				
Untreated clam, . .	–	64,000	4,000	660	0	+	+	+
Control, ...	–	5,300	300	50	0	0	+	+
	10	3,400	170	60	0	0	+	+
	20	7,000	240	90	0	0	+	+
	30	2,000	140	30	0	0	+	+
	40	4,800	260	110	0	0	+	+
	50	3,800	270	70	0	0	0	+
	60[1]	2,600	219	45	0	0	0	+
	70[1]	1,800	180	36	0	0	+	+
Elapsed Time, Forty-eight Hours.								
Control, ...	–	7,800	150	30	0	+	+	+
	60	2,500	117	46	0	0	+	+
	70	4,700	160	50	0	0	+	+

---

[1] Free chlorine present at the end of the experiment.

Experiment No. 3.

This experiment was carried on along the same lines as the previous one, but thirty clams were immersed in the solutions. The first solution contained 2.5 parts per 1,000,000 free chlorine; the second, 1 part in 1,000, or .1 per cent., free chlorine. A control was carried on as usual. It had been thought that in these weak chlorine solutions the clams would perform their usual biological functions, and the solutions would be drawn within the shells. The weak solutions, however, had no effect on the clams or the enclosed bacteria; in fact, bacteria growing at 20° C. apparently increased after one hour's immersion. The acid-forming bacteria at 37° C. were reduced by the weak solution.

Bacterial Analyses of the Average Shell-water from Five Clams.

Elapsed Time, One Hour.

	Free Chlorine (Parts per Million).	Bacteria per Cubic Centimeter.			B. Coli.			
		4 Days, 20° C.	24 hours, 37° C.		.001 Cubic Centimeter.	.01 Cubic Centimeter.	0.1 Cubic Centimeter.	1.0 Cubic Centimeter.
			Total.	Red.				
Untreated clam,	-	-	-	-	-	-	-	-
Control,	-	16,000	4,100	1,100	+	+	+	+
	2½	27,000	1,400	650	0	0	+	+
	1,000[1]	12,800	700	70	0	0	+	+
Elapsed Time, Twenty-four Hours.								
Control,	-	23,000	2,800	1,200	+	+	+	+
	1,000[1]	-	1,800	760	0	0	+	+

[1] Or .1 per cent.; free chlorine present at the end of the experiment.

Experiment No. 4.

These previous experiments with their bacterial and free chlorine results showed that when the clams were immersed in weak solutions not enough water was taken within the shells to be effective in the reduction of bacteria. They did show, however, that when immersed in strong solutions the small amount taken within the shells had considerable effect, hence experiments were made with strong solutions containing 0.8, 1.3 and 1.7 per cent. of free chlorine, respectively. The results of this work are shown in the following table: —

Bacterial Analyses of the Average Shell-water from Five Clams.

Elapsed Time, One Hour.

	Free Chlorine (Per Cent.).	Bacteria per Cubic Centimeter.			B. Coli.			
		4 Days, 20° C.	24 hours, 37° C.		.001 Cubic Centimeter.	.01 Cubic Centimeter.	0.1 Cubic Centimeter.	1.0 Cubic Centimete
			Total.	Red.				
Untreated clam,	-	11,400	500	100	0	0	+	+
Control,	-	2,300	130	40	0	0	0	+
	0.8[1]	2,100	4	0	0	0	0	+
	1.3[1]	800	19	5	0	0	0	0
	1.7[1]	43	1	0	0	0	0	0

[1] Free chlorine present in bleaching powder solution and average shell-water at end of experiment.

In addition to the bacterial analyses shown above, the approximate number of *B. coli* was determined in the shell-waters from five clams by the scoring method, as shown in the following table: —

Results of B. Coli Test with Dilutions indicated, after One Hour's Immersion.

	Sample No.	B. Coli.				Score.	Approximate B. Coli in 1 Cubic Centimeter of Shell-water.
		1.0 Cubic Centimeter.	0.1 Cubic Centimeter.	.01 Cubic Centimeter.	.001 Cubic Centimeter.		
Untreated clam, . . .	1	+	0	0	0	1	
	2	+	+	0	0	10	
	3	+	0	0	0	1	
	4	+	+	0	0	10	
	5	+	+	0	0	10 — 32	6.0
Control, ...	1	+	0	0	0	1	
	2	+	0	0	0	1	
	3	+	0	0	0	1	
	4	+	0	0	0	1	
	5	+	0	0	0	1 — 5	1.0
0.8 per cent. free chlorine, .	1	0	0	0	0	0	
	2	0	0	0	0	0	
	3	+	0	0	0	1	
	4	0	0	0	0	0	
	5	0	0	0	0	0 — 1	0.2
1.3 per cent. free chlorine, .	1	0	0	0	0	0	
	2	0	0	0	0	0	
	3	0	0	0	0	0	
	4	+	+	0	0	1	
	5	0	0	0	0	1 — 2	0.4
1.7 per cent. free chlorine, .	1	0	0	0	0	0	
	2	+	0	0	0	1	
	3	0	0	0	0	0	
	4	0	0	0	0	0	
	5	0	0	0	0	0 — 1	0.2

	Per cent. removal.
Control, ...	83
0.8 per cent. free chlorine, ...	97
1.3 per cent. free chlorine, ...	93
1.7 per cent. free chlorine, ...	97

Conclusions.

The taste of the clams after immersion in these strong solutions was not determined, but the odors were very disagreeable, and clams treated in this manner would have to be thoroughly washed to remove the chlorine odor before being placed on the market.

It is evident from all this work that clams have the power to prevent circulation of the water within their shells; that the shell-water present at the time of immersion is largely held there and the water containing chlorine largely shut out; that a small amount only of this chlorine water enters; that with weak solutions this amount is not great enough to sterilize the clam; and that only when the solutions in which the clams are placed are very strong in free chlorine is the small amount taken within the shell effective.

TREATMENT OF SHUCKED CLAMS WITH CHLORINE.

In experiments not summarized here it was found that about 1,000 parts per 1,000,000 available chlorine practically sterilized shucked clams. Results with lower amounts of chlorine were as follows: To portions of shucked clams which were received in a rather dry condition, 50 per cent. of a 1 per cent. sterile salt solution containing 1.0, 8.8, 106 and 920 parts per 1,000,000 available chlorine was added, and after standing one hour three portions were taken from each for analysis. Averaging the results from the three portions, the untreated clams contained 500,000 bacteria at 20° C., 4,900 total and 2,300 acid-forming bacteria at 37° C., and 333 *B. coli* per cubic centimeter determined by fermentation tests. The three lower amounts of chlorine did not materially reduce the bacteria growing on agar at 20° C. and 37° C., but all three reduced the *B. coli* to 100 per cubic centimeter. Nine hundred and twenty parts per 1,000,000 available chlorine reduced the 20° C. bacteria to 132,000, the total bacteria at 37° C. to 720 and the acid-forming bacteria to 220, and *B. coli* to 3 per cubic centimeter. The odor of free chlorine remained after one hour in the clams receiving 920 parts chlorine. With the other portions tested no odor of chlorine was noticed.

These experiments confirm the previous results, and indicate that shucked clams cannot be purified by any practicable amount of available chlorine. The odor and taste of chlorine are all too evident.

CHLORINATION OF OYSTERS.

A test with 0.25 part per 1,000,000 available chlorine was made under conditions which as nearly as possible duplicated those of the United States Public Health laboratory experiments.

In this test 5 gallons of water were used, and this water was replaced three times in the first five hours and four times during twenty-four hours with water containing the theoretical amount of chlorine. The results of this test were entirely negative, as the bacteria in the shell-water of the oysters after five and twenty-four hours' treatment were higher than in the shell-water of untreated oysters.

Tests of Efficiency of Double Check Valve Systems.

In November, following a request made several months previously by the Factory Mutual Insurance Companies, tests were begun at the Naumkeag Steam Cotton Mills, Salem, in regard to the efficiency of the double check valve system, so called.

At these mills, as at many others, there is an auxiliary fire supply controlled by the mill and separate from the municipal supply. The object of this auxiliary supply is, of course, to render the property doubly safe in time of fire. The auxiliary supply at the Naumkeag Mills is taken from Salem Harbor. Normally, the mains and sprinkler systems at these mills are filled with water from the municipal supply under about 80 pounds' pressure. The fire pumps of the auxiliary supply are capable of producing 120 pounds' pressure; hence when in use they would force the harbor water into the city mains unless adequate preventive appliances were adopted. This is believed by the insurance companies to be attained by placing double check valves at the entrance of the city mains to the mill yards. These check valves are supposed to work easily and to be closed tightly when the pressure from the fire pumps exceeds the city pressure.

On three separate days, with the fire pumps in operation filling the mains within the mill yard and with two large fire streams working, chemical and bacterial samples for examination were taken on each side of the two check valve systems in use. The pressure on the mill fire system was on two of these days always greater than the municipal pressure, and on the third day, while greater during most of the period of test, was lowered twice to a pressure less than the municipal pressure. Samples for determinations of chlorine and bacteria were taken frequently during the period when the mill fire pumps were working, and the results of these examinations, together with pressure readings, are given in following tables. These results show that during these days of tests the valves worked successfully under the conditions existing, and that passage of salt harbor water into the mains on the city side of the check valves was prevented.

No general conclusions in regard to the universal effectiveness and safety of these devices can be drawn from such tests, however. It is only by frequent inspection and tests that the safety of such devices can be assured.

Naumkeag Mills, Salem, Mass., Nov. 28, 1916.

Lower Valve, City Side.

Time of Collection.	Pressure (Pounds per Square Inch).		Chemical Analyses (Parts in 100,000).			Bacteria per Cubic Centimeter.			B. Coli.		
	City Side.	Yard Side.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	4 Days, 20° C.	24 hours, 37° C.		0.1 Cubic Centimeter.	1.0 Cubic Centimeter.	10 Cubic Centimeters.
							Total.	Red.			
-	-	-	-	-	-	32	7	4	0	0	+
11.30 A.M.[1]	-	-	.0040	.0184	1.11	-	-	-	-	-	-
11.50 A.M.	-	-	.0090	.2760	1.09	-	-	-	-	-	-
12.05 P.M.	62	115	.0080	.1120	1.12	-	-	-	-	-	-
12.30 P.M.	-	115	.0076	.0404	1.09	-	-	-	-	-	-
2.30 P.M.	80	96	-	-	-	160	19	9	0	+	+
2.50 P.M.	80	110	.0100	.0320	1.07	220	18	7	0	0	+
3.05 P.M.	79	105	.0056	.0324	1.06	240	15	3	0	0	+
3.25 P.M.	81	100	.0052	.0272	1.07	165	19	10	0	0	+
3.45 P.M.	80	96	.0072	.0348	1.07	132	50	32	0	0	+
4.05 P.M.	80	108	.0064	.0308	1.09	121	19	7	0	0	+

Lower Valve, Yard Side.

Time of Collection.	City Side.	Yard Side.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	4 Days, 20° C.	Total.	Red.	0.1 Cubic Centimeter.	1.0 Cubic Centimeter.	10 Cubic Centimeters.
11.50 A.M.	-	-	.0090	.1560	1.08	-	-	-	-	-	-
12.05 P.M.	62[2]	115	.0120	.0590	1.12	-	-	-	-	-	-
3.05 P.M.	-	-	.0112	.0256	2.49	240	16	9	0	0	+
3.25 P.M.	-	-	-	-	-	260	27	15	0	0	+
3.45 P.M.	80	96	.0104	.0284	5.15	310	17	5	0	0	+
4.05 P.M.	80	108	.0052	.0248	5.70	320	16	9	0	0	+

Harbor at Intake of Fire Supply.

Time of Collection.	City Side.	Yard Side.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	4 Days, 20° C.	Total.	Red.	0.1 Cubic Centimeter.	1.0 Cubic Centimeter.	10 Cubic Centimeters.
2.30 P.M.	80	96	.0240	.0160	1,735.00	-	-	-	-	-	-

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[1] Before flushing.

[2] Nozzle.

Naumkeag Mills, Salem, Mass., Dec. 1, 1916.

Lower Valve, City Side.

Time of Collection.	Pressure (Pounds per Square Inch).		Chemical Analyses (Parts in 100,000).			Bacteria per Cubic Centimeter.			B. Coli.		
	City Side.	Yard Side.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.	4 Days, 20° C.	24 hours, 37° C.		0.1 Cubic Centimeter.	1.0 Cubic Centimeter.	10 Cubic Centimeters.
							Total.	Red.			
12.25 P.M.[1]	81	115	–	–	1.07	76	27	8	0	0	0
12.45 P.M.	80	125	.0100	.0260	1.08	111	22	3	0	0	0
1.00 P.M.	80	115	–	–	1.08	134	19	9	0	0	0
1.20 P.M.	80	110	.0068	.0232	1.08	98	24	6	0	0	0
1.35 P.M.	77	115	–	–	1.08	139	15	8	0	0	0
1.50 P.M.	78	120	.0100	.0244	1.08	161	16	8	0	0	0
2.05 P.M.	78	110	–	–	1.09	156	16	0	0	0	0
Lower Valve, Yard Side.											
12.20 P.M.[1]	–	–	–	–	1,680.00	–	–	–	–	–	–
12.30 P.M.	–	–	–	–	–	490	29	7	0	+	+
1.00 P.M.	80	115	–	–	1,675.00	370	108	32	+	+	+
1.35 P.M.	77	115	–	–	1,715.00	530	57	19	+	+	+
2.05 P.M.	78	110	.0092	.0224	1,725.00	440	52	24	0	+	+
Upper Valve, City Side.											
11.30 A.M.[2]	–	–	–	–	1.07	–	–	–	–	–	–
1.07 P.M.	–	110	–	–	1.07	–	–	–	–	–	–
1.20 P.M.	–	110	–	–	1.08	169	8	2	0	0	+
1.35 P.M.	–	117	–	–	1.08	77	11	5	0	0	+
1.50 P.M.	–	112	–	–	1.08	24	13	7	0	0	+
2.05 P.M.	–	113	.0088	.0220	1.06	74	8	0	0	0	0
2.20 P.M.	–	102	–	–	1.02	96	4	0	0	0	0
2.35 P.M.	–	110	.0112	.0228	1.09	42	5	0	0	0	+
Upper Valve, Yard Side.											
1.09 P.M.	–	110	–	–	1,740.00	–	–	–	–	–	–
1.35 P.M.	–	117	–	–	–	220	20	8	0	0	+
2.35 P.M.	–	110	–	–	1,770.00	150	20	11	0	0	+
2.55 P.M.	–	113	–	–	–	107	15	9	0	0	+

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[1] After flushing through hose to bring salt water up against check.

[2] After flushing with city water.

Naumkeag Mills, Salem, Mass., Dec. 8, 1916.

Upper Valve, City Side.

Time of Collection.	Pressure (Pounds per Square Inch).		Chlorine (Parts in 100,000).	Bacteria per Cubic Centimeter.			B. Coli.		
	City Side.	Yard Side.		4 Days, 20° C.	24 hours, 37° C.		0.1 Cubic Centimeter.	1.0 Cubic Centimeter.	10 Cubic Centimeters.
					Total.	Red.			
10.45 A.M.[1]	–	–	1.09	7,600	8	0	0	0	0
11.35 A.M.	80	110	1.09	1,500	85	29	0	0	0
11.47 A.M.	80	115	1.08	450	1	1	0	0	0
12.00 M.	80	118	1.08	500	1	0	0	0	0
12.05 P.M.	82	115	1.08	–	–	–	–	–	–
12.15 P.M.	82	115	–	700	2	0	0	0	0
12.35 P.M.	80	113	1.08	800	19	1	0	0	0
12.55 P.M.	80	120	1.08	1,100	5	0	0	0	0
1.17 P.M.	78	120	1.08	800	1	0	0	0	0
1.26 P.M.	78	125	1.08	–	–	–	–	–	–

Upper Valve, Yard Side.

11.35 A.M.	80	110	1,735.00	–	–	–	–	–	–
11.47 A.M.	80	115	–	340	4	2	0	0	+
12.35 P.M.	80	113	1,640.00	–	–	–	–	–	–
12.55 P.M.	80	120	1,575.00	540	3	0	0	0	+
1.17 P.M.	78	120	1,680.00	–	–	–	–	–	–

Lower Valve, City Side.

10.50 A.M.	88	95	1.08	1,100	7	0	0	0	+
11.15 A.M.	85	115	1.08	660	2	0	0	0	0
11.35 A.M.	83	110	1.08	360	0	0	0	0	0
11.50 A.M.	84	118	1.08	550	12	1	0	0	+
12.10 P.M.	85	117	1.08	540	2	1	0	0	+
12.45 P.M.	84	113	1.08	500	0	0	0	0	0
12.55 P.M.	82	110	1.09	600	5	0	0	0	0
1.15 P.M.	82	125	1.08	–	–	–	–	–	–

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[1] Before starting test.

Naumkeag Mills, Salem, Mass., Dec. 8, 1916 — Concluded.

Lower Valve, Yard Side.

Time of Collection.	Pressure (Pounds per Square Inch).		Chlorine (Parts in 100,000).	Bacteria per Cubic Centimeter.			B. Coli.		
	City Side.	Yard Side.		4 Days, 20° C.	24 hours, 37° C.		0.1 Cubic Centimeter.	1.0 Cubic Centimeter.	10 Cubic Centimeters.
					Total.	Red.			
11.15 A.M.	85	115	1,780.00	180	10	3	0	0	+
12.10 P.M.	85	117	1,715.00	-	-	-	-	-	-
12.35 P.M.	-	-	-	420	4	2	0	0	+
12.45 P.M.	-	-	-	500	2	1	0	0	0
12.55 P.M.	82	110	3.40[1]	-	-	-	-	-	-
1.15 P.M.	82	125	1.30[1]	-	-	-	-	-	-

Harbor at Intake of Fire Supply.

10.00 A.M.	-	-	-	300	37	16	0	0	+

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[1] Fire pumps stopped a few minutes allowing city water to enter.

EXPERIMENTS UPON THE PURIFICATION OF SEWAGE AND WATER AT THE LAWRENCE EXPERIMENT STATION DURING THE YEAR 1916.

CHARACTER OF THE SEWAGE USED IN THE EXPERIMENTS.

Since September, 1915, sewage has been pumped from the Osgood Street sewer, so called. This sewage is somewhat weaker than that used in former years, and, coming from a shorter distance, it arrives at the station in a fresher condition, and there are greater and more frequent fluctuations in its strength, than in that pumped for so many years from the Lawrence Street sewer. Late in 1916 temporary repairs made upon the old pipe line allowed sewage to be pumped from both sewers.

In the fall a plant was established near the Osgood Street sewer to treat wool-scouring liquors for the recovery of potash and fats, and at intervals the waste liquors were discharged from this plant for a few minutes into the sewer and pumped to the station. Some of this waste was allowed to mingle with the sewage applied to the filters.

"Regular station sewage" is the average of samples collected four times each day of the sewage as it reaches the experiment station; "settled station sewage" is the same sewage settled for at least two hours in a cylindrical tank; "sewage applied to Filters Nos. 1, 6 and 9A" is the average of daily samples of all the sewage applied to the large intermittent filters situated out of doors.

The average analyses of the various representative samples of sewage collected during the year are shown in the tables on pages 124 and 125.

PRELIMINARY TREATMENTS FOR THE CLARIFICATION OF SEWAGE.

Comparative studies of the clarification of sewage (1) by sedimentation, (2) by sedimentation preceded by aeration in tanks containing layers of slate, (3) by straining through a layer of anthracite coal, and (4) by chemical precipitation were continued during the year.

Sedimentation in Open Tanks.

The tank installed in 1906 for the clarification of sewage by sedimentation is cylindrical, with the bottom sloping at an angle of 60°. Throughout the year about 750 gallons of sewage were treated daily in this tank and allowed to settle overnight. The average removal of total suspended matter and of suspended organic matter was about 52 per cent. and 46 per cent., respectively. Sludge was drawn from the bottom of the tank twice a week. The average weight of dry sludge removed during the year was 323 pounds per 1,000,000 gallons of sewage, this being somewhat less than formerly, owing partly to the fact that during the past winter a growth occurred in the sewer pipe which retained about three-quarters of the suspended solids. This growth sloughed off when warm weather came.

Precipitation with Sulphate of Alumina.

Throughout the year sewage was treated daily with sulphate of alumina at the rate of 5 grains per gallon. After settling four hours the clarified sewage was applied to a trickling filter and to a sand filter, and the results are given in a subsequent portion of this report. The average removal of total suspended matter was 62 per cent. and of total organic matter 52 per cent., as shown by the determinations of solids.

Straining through Anthracite Coal.

Strainer E, containing 12 inches in depth of buckwheat coal, and first put into operation in 1901, was operated at a rate of 1,000,000 gallons per acre daily throughout the year. Three times it was found necessary to rake the surface to a depth of 3 inches during the year. The average removal of total suspended matter was 69 per cent. This strainer was discontinued at the end of the year, and while the results of its operation on the whole were rather remarkable, its work is done now more efficiently by other forms of treatment.

Average Analyses.

Regular Station Sewage.

[Parts in 100,000.]

AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	Oxygen consumed.	Bacteria per Cubic Centimeter.
Free.	ALBUMINOID.						
	Total.	In Solution.	Total.	In Solution.			
2.03	.41	.27	.95	.60	4.00	3.36	887,000

Average Analyses — Concluded.

Settled Station Sewage.

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Oxygen consumed.	Bacteria per Cubic Centimeter.
Free.	Albuminoid.		Total.	In Solution.			
	Total.	In Solution.					
1.84	.27	.18	.59	.39	4.10	2.15	1,115,500
Sewage applied to Filters Nos. 1, 6 and 9A.							
1.67	.29	–	.70	–	3.91	2.39	–
Effluent from Strainer E.							
1.62	.21	.14	.49	.38	3.51	1.48	890,000
Sewage precipitated with Sulphate of Alumina.							
1.61	.17	.11	.53	.39	3.63	1.25	102,000

Average Solids.

Regular Station Sewage.

[Parts in 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
37.6	19.6	18.0	26.6	12.6	14.0	11.0	7.0	4.0
Settled Station Sewage.								
33.2	15.8	17.4	27.9	12.0	15.9	5.3	3.8	1.5
Effluent from Strainer E.								
26.7	11.7	15.0	23.3	9.2	14.1	3.4	2.5	0.9
Sewage precipitated with Sulphate of Alumina.								
25.6	9.4	16.2	21.6	7.4	14.2	4.0	2.0	2.0

Purification of Sewage by Aeration.

The slate aerating tank, first started in January, 1913, was operated throughout the year, and the activated sludge tank, started last year, was operated seven months and then replaced by a similar larger tank.

Aeration in Slate Tanks.

Slate aerating Tank No. 449 was operated one cycle daily throughout the year. Six hours' aeration was allowed and air supplied at an average rate of 150,000 cubic feet per hour per 1,000,000 gallons of sewage treated or nine-tenths of a cubic foot of air per gallon of sewage. Samples were collected for analysis after three hours' aeration, as well as at the end of aeration. Neither sludge nor deposits on the slates were removed from the tank during the year except for analysis. After three and six hours' aeration, 40 per cent. and 72 per cent., respectively, of the samples were stable. The removal of suspended solids by this tank was good, averaging 81 per cent. and 91 per cent. in three hours and six hours, respectively. The effluent remained rather opalescent.

Aerating Tank No. 449B, receiving the effluent from aerating Tank No. 449, was aerated six hours at the rate of 50,000 cubic feet per hour per 1,000,000 gallons of sewage treated. As Tank No. 449 removes the greater part of the suspended solids of the sewage there is little accumulation in this secondary tank. After April 1 this tank was emptied daily; previously, one-third of the dose was left in the tank to aid the establishment of nitrification. Its effluent was very slightly opalescent, entirely stable and practically free from suspended matter, the average being 0.9 part in 100,000, — a reduction of 91 per cent.

Aeration in Activated Sludge Tanks Nos. 465, 482 and 484. High and Low Temperatures.

Tank No. 465, started in February, 1915, and operated until July 22 of this year, was 4 feet deep and had a capacity of 110 gallons exclusive of the conical bottom. From January 10 to July 22 it was operated 3 cycles daily with three hours' aeration with air at the rate of 250,000 cubic feet per hour per 1,000,000 gallons of sewage treated, or three-fourths of a cubic foot of air per gallon of sewage, and one hour was allowed for settling.

On January 11 a smaller similar tank, No. 482, holding about 25 gallons, was started with some of the activated sludge from Tank No. 465. The sewage applied was heated to 60° F. during the winter months, while the average temperature of the sewage in Tank No. 465

ranged from 40° F. at the beginning of aeration to 45° F. at the end. Over 90 per cent. of the samples from both tanks were stable, and the removal of organic matter from the applied sewage was practically the same in each tank. Purification was as good at 40° F. as at 60° F. Both tanks, especially No. 482, had intervals in which they seemed to "unload;" that is, the soluble organic matter was higher in the effluent than in the applied sewage. There may be some connection between the higher number of bacteria in the sludge from Tank No. 482 and this unloading. The same action was also noticed in similar work with tannery wastes described later on.

The removal of suspended solids was not quite as good as effected by the slate tanks previously described, one hour settling not being sufficient for the lighter suspended matter to settle completely. The removal of total suspended solids by Tank No. 465 and Tank No. 482 was 79 per cent. and 84 per cent., respectively. These two tanks were discontinued on August 15.

On August 24 a new activated sludge tank, No. 484, about 8 feet deep and 44 inches square, and with a capacity of about 600 gallons, was put into operation. Near the bottom, which is 12 inches wide, two of the sides have a 2½ to 1 slope. Air is applied through two filtros plates 6 by 12 inches, and set in movable concrete boxes. Sludge from the two discontinued tanks and from other sources was placed in this tank until it was about one-fifth full. This tank was operated 3 cycles daily, allowing two and one-half hours' aeration at each filling, 150,000 cubic feet of air per hour per 1,000,000 gallons of sewage treated, or about .4 cubic foot of air per gallon of sewage, and one and one-half hours' settling. After about five weeks' use the surface of the filtros plates became so badly clogged that only by excessive pressure could the required amount of air be driven through. A thorough brushing of the surface improved conditions, but the air then came in larger bubbles and from fewer holes. It has since been necessary to clean the plates about once a month. This is somewhat oftener than the jets in the slate tanks need attention. The filtros plate when not clogged gave a satisfactory distribution of air.

The effluent from Tank No. 484 has not been as yet of quite as good quality as that from the smaller tank, No. 465, partly because at the beginning the sludge had not become wholly activated and partly because the air supplied in the two and one-half hour period of aeration was insufficient. The average reduction of total suspended solids was 64 per cent. On November 16 the method of operation was changed to 2 cycles with three and one-half hours' aeration, which resulted in a decided improvement.

Coagulation of Colloids.

In any roughing treatment of sewage one of the most important considerations is the coagulation of colloidal matters. Slate Tank No. 449 reduced this matter 51 per cent. in three hours and 52 per cent. in six hours, while aeration in secondary Tank No. 449B increased the reduction to 62 per cent. The average reductions by the activated sludge tanks were 53 per cent. by Tank No. 465; 44 per cent. by Tank No. 482; and 61 per cent. by Tank No. 484.

Cause of the Increase of Organic Nitrogen in Activated Sludge.

Much has been written during the past year or two in regard to the increased nitrogen content in the sludge from the activated sewage process. Statements have been made that this increase is caused very largely by fixation of nitrogen. This may be so in some instances. In the Lawrence tanks treating domestic sewage, however, this increase appears to be largely due to the collection and coagulation of colloids and their retention in the sludge. The colloidal matters in the Lawrence sewage have been shown by us to contain from two to three times as much organic nitrogen as those coarser matters in suspension that are deposited under ordinary conditions and are easily filtered out from sewage.

Careful determinations through many months with actual determinations of the percentage by weight that the colloids are of the total matters in the sludge, together with analyses of nitrogen, have shown that the nitrogen of the colloids is from two to three times as great as the nitrogen in the coarser suspended solids of the sludge and that the actual increase of nitrogen in the sludge, due to these colloids, is about 33 per cent. For example, taking Tanks Nos. 465 and 484 to illustrate this point, the actual average percentage of nitrogen in the coarse suspended solids of the sewage entering these tanks is 2.35 per cent. of the total weight and about 6 per cent. of the colloidal matters is organic nitrogen.

From these figures and careful determinations of the percentage that the colloidal deposits are of the total sludge deposits, we have found that of the increased nitrogen in the sludge above that found in the coarser matters, three-quarters is due to the colloidal matters deposited and one-quarter to causes as yet unexplained; partly, perhaps, due to the fixation of nitrogen, and partly to the relative increase of nitrogen due to the oxidation and removal of carbonaceous matters. This is being investigated.

Investigations with this activated process as applied to tannery sewage have shown that the increase in nitrogen in the sludge has apparently come very largely from other sources than the increase due to coagulation and deposit of colloids.

Average Analyses.

Sewage applied to Slate Aerating Tank No. 449.

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Nitrogen as —		Oxygen consumed.
Free.	Albuminoid.							
	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.	
1.64	.35	.22	.91	.57	3.66	-	-	2.75

Effluent from Slate Aerating Tank No. 449 after Three Hours' Aeration.

1.48	.17	.12	.37	.28	3.64	.04	.0025	1.31

Effluent from Slate Aerating Tank No. 449 after Six Hours' Aeration.

1.64	.15	.12	.35	.28	3.51	.04	.0018	1.21

Effluent from Slate Aerating Tank No. 449B after Six Hours' Aeration.

1.49	.10	.08	-	-	3.52	.17	.0042	0.90

Sewage applied to Activated Sludge Tanks Nos. 465 and 482.

1.45	.32	.20	.78	.50	3.64	-	-	2.46

Effluent from Activated Sludge Tank No. 465 after Three Hours' Aeration. — Three Cycles.

1.58	.14	.10	.34	.23	3.84	.03	.0020	1.14

Effluent from Activated Sludge Tank No. 482 after Three Hours' Aeration. — Three Cycles.

1.53	.17	.12	.42	.28	3.51	.02	.0028	1.02

Sewage applied to Activated Sludge Tank No. 484.

1.44	.42	.26	.92	.61	3.39	-	-	3.17

Effluent from Activated Sludge Tank No. 484 after Two and One-half Hours' Aeration. — Three Cycles.

1.00	.17	.11	.39	.24	3.96	.08	.0018	1.41

Average Solids.

Sewage applied to Slate Aerating Tank No. 449.

[Parts in 100,000.]

UNFILTERED.			FILTERED.			IN SUSPENSION.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
35.4	18.6	16.8	26.1	12.8	13.3	9.3	5.8	3.5

Effluent from Slate Aerating Tank No. 449 after Three Hours' Aeration.

24.3	10.1	14.2	22.5	8.9	13.6	1.8	1.2	0.6

Effluent from Slate Aerating Tank No. 449 after Six Hours' Aeration.

21.5	8.3	13.2	20.6	8.0	12.6	0.9	0.3	0.6

Effluent from Slate Aerating Tank No. 449B after Six Hours' Aeration.

22.2	7.3	14.9	21.3	7.0	14.3	0.9	0.3	0.6

Sewage applied to Activated Sludge Tanks Nos. 465 and 482.

35.8	19.5	16.3	25.9	12.1	13.8	9.9	7.4	2.5

Effluent from Activated Sludge Tank No. 465 after Three Hours' Aeration. — Three Cycles.

23.8	9.0	14.8	21.7	7.9	13.8	2.1	1.1	1.0

Effluent from Activated Sludge Tank No. 482 after Three Hours' Aeration. — Three Cycles.

22.1	8.8	13.3	20.5	7.9	12.6	1.6	0.9	0.7

Sewage applied to Activated Sludge Tank No. 484.

46.0	25.0	21.0	36.0	16.5	19.5	10.0	8.5	1.5

Effluent from Activated Sludge Tank No. 484 after Two and One-half Hours' Aeration. — Three Cycles.

27.9	12.1	15.8	24.3	10.0	14.3	3.6	2.1	1.5

Stability.

	Cubic Foot of Air per Gallon of Sewage.	Per Cent. of Samples Stable.
Effluent from slate aerating Tank No. 449: —		
3 hours' aeration,	½	40
6 hours' aeration,	9/10	72
Effluent from slate aerating Tank No. 449B: —		
6 hours' aeration,	3/10	100
Effluent from activated sludge Tank No. 465: —		
3 hours' aeration, 3 cycles,	¾	93
Effluent from activated sludge Tank No. 482: —		
3 hours' aeration, 3 cycles,	¾	94
Effluent from activated sludge Tank No. 484: —		
2½ hours' aeration, 3 cycles,	4/10	89

OPERATION OF TRICKLING FILTERS.

During 1916, 11 trickling filters receiving domestic sewage clarified by some form of treatment, and 2 receiving trade wastes, were operated at the station. Filter No. 135 has been in operation seventeen years, and contains 10 feet in depth of pieces of stone having an average cubic content of .52 cubic centimeter, and passing a 1-inch screen but retained by a ¼-inch screen. In former years, when much stronger sewage was applied, the filter was usually operated at nearly the maximum possible rate. Now that the applied sewage is much weaker, the maximum rate with this weaker sewage is being determined and a study made of the relation between rate and strength of sewage.

The Filtration of Aerated and Chemically Precipitated Sewage through Trickling Filters.

Filter No. 449 was started in 1913 and contains 10 feet in depth of broken stone of an average volume of 5.06 cubic centimeters and passing a 2-inch screen but retained by a 1-inch screen. The effluent from slate aerating Tank No. 449 was applied to this filter at a rate of nearly 10,000,000 gallons per acre daily throughout the year. Over 96 per cent. of the samples of effluent were stable.

Filter No. 457, similar in construction to Filter No. 449, was started in 1914 to study in connection with the latter the comparative effect of aeration and chemical precipitation as a preliminary treatment of sewage for filtration in trickling filters.

Average Analyses.

Effluent from Filter No. 135.

[Parts in 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as —		Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
				Albuminoid.								
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.			
2,286,100	1.9	.57	0.4620	.1527	.0937	.34	4.10	1.26	.0031	1.30	3.0	101,000

Effluent from Filter No. 449.

9,854,000	2.9	.64	1.5852	.1338	.0988	.30	3.75	0.54	.0039	1.10	7.8	177,000

Effluent from Filter No. 457.

5,896,500	2.3	.34	1.7200	.1508	.0606	.34	3.68	0.57	.0030	0.81	5.4	192,000

THE DEPTH OF FILTERING MATERIAL AND TRICKLING FILTER EFFICIENCY.

It was shown in the last report that trickling filters of a considerable depth are more economical and efficient than shallower filters. This efficiency was shown to be due to the fact that the sewage is relatively a much longer time in passing through the deeper filters, and to the progressive mixture of the applied and the held sewage. It was shown, for instance, that with equal rates of application the sewage was five or six times as long passing through a 10-foot as through a 5-foot filter of this class. The higher rates at which these filters could be operated were directly proportional to this increase in time.

The filters from which these results were obtained, Nos. 452 to 455, inclusive, and Nos. 472 to 475, inclusive, were continued during the year. In each series the depths are 4, 6, 8 and 10 feet, respectively. The material in the first series of filters is of such size that it passes a 1½-inch screen and is retained by a ¾-inch screen. The average volume of the pieces of stone ranges from 3.90 cubic centimeters to 5.33. In the second series the stone is much larger and was hand sorted, the average volume ranging from 25.2 to 29.4 cubic centimeters.

During 1916 it was intended to maintain such rates for all these filters that the average nitrates in their effluents would be about 1.0 part in 100,000, as experience has shown that with the Lawrence sewage now used this amount of nitrification insures an effluent of fair stability. With the two 4-foot filters it was not possible to get this amount of nitrification without reducing the rate below that practical to maintain with the method of flooding that was used, and their effluents were of a low degree of stability.

To aid in determining the comparative condition of each effluent, the amount of oxygen absorbed by each on incubating for twenty-four hours at 70° F. in closed bottles was determined at least once a month and the results are shown in the following table. More frequent samples from Filters Nos. 452 to 455, inclusive, would have equalized the irregular unloading of these filters and given more uniform results. On incubation, part of the oxygen absorbed is taken from the dissolved oxygen and part from the nitrates and nitrites. It was assumed in making these calculations that three-fourths of the nitrite oxygen and five-sixths of the nitrate oxygen were available.

Average Oxygen absorbed by Effluents from Filters Nos. 452, 453, 454, 455, 472, 473, 474 and 475.

Effluent from Filter No. 452.

[Parts in 100,000.]

Dissolved Oxygen.	Oxygen from Nitrates.	TOTAL OXYGEN ABSORBED.	
		1916.	Average for Three Years.
.33	1.18	1.51	1.32

Effluent from Filter No. 453.

.33	1.31	1.64	1.31

Effluent from Filter No. 454.

.27	0.82	1.09	1.02

Effluent from Filter No. 455.

.38	0.90	1.28	1.22

Effluent from Filter No. 472.

.33	1.28	1.61	-

Effluent from Filter No. 473.

.36	1.41	1.77	-

Average Oxygen absorbed by Effluents from Filters Nos. 452, 453, 454, 455, 472, 473, 474 and 475 — Concluded.

Effluent from Filter No. 474.

[Parts in 100,000.]

Dissolved Oxygen.	Oxygen from Nitrates.	Total Oxygen absorbed.	
		1916.	Average for Three Years.
.37	1.20	1.57	–

Effluent from Filter No. 475.

.42	1.30	1.72	–

Average Analyses.

Effluent from Filter No. 452 (4 Feet in Depth).

[Parts in 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as—		Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
				Albuminoid.								
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.			
410,000	2.8	.63	1.0517	.2030	.1500	.44	4.34	.73	.0066	1.66	6.3	550,000

Effluent from Filter No. 453 (6 Feet in Depth).

931,000	2.7	.62	0.7617	.1920	.1178	.40	4.18	.92	.0119	1.50	5.1	376,000

Effluent from Filter No. 454 (8 Feet in Depth).

1,471,500	2.5	.60	0.8467	.1910	.1265	.39	4.20	.99	.0060	1.42	5.0	173,000

Effluent from Filter No. 455 (10 Feet in Depth).

3,837,000	2.8	.65	0.7333	.1800	.1147	.36	4.21	1.06	.0050	1.44	4.2	557,000

Average Analyses — Concluded.

Effluent from Filter No. 472 (4 Feet in Depth).

[Parts in 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as —		Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
				Albuminoid.								
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.			
339,300	3.1	.64	1.0367	.2215	.1468	.46	4.13	.62	.0092	1.64	6.7	860,000

Effluent from Filter No. 473 (6 Feet in Depth).

714,200	2.9	.63	0.7267	.1758	.1153	.36	4.21	.98	.0064	1.42	5.6	350,000

Effluent from Filter No. 474 (8 Feet in Depth).

1,004,000	2.7	.56	0.8633	.1933	.1370	.40	4.29	.82	.0083	1.38	5.6	520,000

Effluent from Filter No. 475 (10 Feet in Depth).

1,814,300	2.7	.56	0.8533	.2172	.1437	.45	4.35	.85	.0058	1.60	5.3	540,000

Average Rates and Results. — Trickling Filters.

Filter Number.	Depth (Feet).	Rate (Gallons per Acre Daily).	Nitrates (Parts in 100,000).	Per Cent. of Samples Stable.
135, ...	10	2,286,100	1.26	100
449, ...	10	9,854,000	0.54	96
452, ...	4	410,000	0.73	78
453, ...	6	931,000	0.92	97
454, ...	8	1,471,500	0.99	97
455, ...	10	3,387,000	1.06	87
457, ...	10	5,896,500	0.57	97
472, ...	4	339,300	0.62	37
473, ...	6	714,200	0.98	91
474, ...	8	1,004,000	0.82	80
475, ...	10	1,814,300	0.85	81

The comparative efficiency of these filters is best shown by the number of gallons filtered for each foot of material, and the following table gives these results for 1916 and since the beginning of operation of the filters. The filters have not always been operated at the intended rates, and the effluents have not been of exactly equal quality, but the results are closely approximate. The rate of Filter No. 472 has been higher than it should have been, as shown by the low stability of its effluent.

Gallons filtered per Acre Daily per Foot of Filter Depth.

Filter Number.	Depth (Feet).	During 1916.	Since Beginning of Operation of Filter.
452,	4	103,000	103,000
453,	6	105,000	113,000
454,	8	184,000	203,000
455,	10	384,000	368,000
472,	4	85,000	100,000
473,	6	119,000	111,000
474,	8	167,000	133,000
475,	10	181,000	140,000

Surface of Filtering Material.

An approximate calculation of the size of the surfaces of the pieces of stone in the two series of filters shows that a given weight or depth of the finer material has about twice as much surface as the coarser. This, together with the fact shown in the last report, that sewage passes more rapidly through the coarser material, explains the lower rates of Filters Nos. 472 to 475, inclusive.

Stabilizing Sludge by Oxidation.

The results of experiments on the treatment of sludge with nitrified effluents given in the last report were so promising that in February, 1916, a three-compartment tank was built to continue the work. The tank, No. 483, is made up of Akron pipe set in concrete, and each compartment is 4 feet deep and holds about 65 gallons. The inlets and overflows are so arranged that the applied filter effluent passes through all three compartments, entering at the bottom and leaving about 6 inches below the surface of each.

All the sludge collected from the settling tanks for one month was put in each compartment in rotation, allowing a maximum storage of three months. Samples of the sludge in each tank were taken twice a month for analysis. The sludge after two or more weeks' treatment is inoffensive, and undergoes a methane fermentation. Previous experience with river muds has shown that methane may be formed in a shallow layer of mud, even when covered with well-aerated water. The solid matter in the applied sludge varied, and for uniformity the volume of sludge applied has been reduced to terms of sludge containing 5 per cent. of solid matter.

The trickling filter effluent added to this tank contained an average of 1.05 parts in 100,000 nitrogen as nitrates, and the overflow of the last compartment, 0.24 part in 100,000.

The average analyses of the applied filter effluent and overflow are shown in the following table: —

Effluent applied to Tank No. 483.

[Parts in 100,000.]

AMMONIA.			Kjeldahl Nitrogen.	NITROGEN AS —		Oxygen consumed.
Free.	ALBUMINOID.			Nitrates.	Nitrites.	
	Total.	In Solution.				
.6606	.1677	.1016	.34	1.05	.0084	1.14

Overflow from Tank No. 483.

.8534	.1484	.0964	.35	0.24	.0351	1.26

The average amount of filter effluent applied daily was one volume for each volume of sludge in the tanks. The organic nitrogen in the overflow was somewhat lower than in the applied effluent, and 88 per cent. of the samples of this overflow were stable. The overflow from the last compartment contained from 10 to 15 per cent. dissolved oxygen by saturation.

The following table shows the average changes in the sludge at different times of treatment, and a few analyses of activated sludge are included for comparison. It will be noted that the greater part of the fats was removed in the first four weeks' treatment in the tank. The draining qualities are not improved above untreated sludge. This tank does not concentrate the nitrogen in the sludge to such an extent as do the activated sludge tanks, but the fat reduction is good.

Condition of Sludge.

Sludge from —	Per Cent. Dry Matter.		Per Cent. on Dry Basis of —		
	After settling Overnight.	After draining Ten Days.	Fats.	Nitrogen.	Loss on Ignition.
Settling tank applied to Tank No. 483,	8.36	67.7	23.5	2.26	58.7
Slate Tank No. 449,	7.02	50.4	7.3	2.88	53.7
Activated Sludge Tank No. 465,	4.42	44.8	4.3	4.35	64.1
Activated Sludge Tank No. 482,	4.39	58.9	6.5	4.19	66.7
Activated Sludge Tank No. 484,	5.90	51.5	6.6	4.09	67.4
Tank No. 483: —					
After 2 weeks,	8.19	64.2	15.7	2.46	57.4
After 4 weeks,	10.29	65.3	12.9	2.39	58.2
After 6 weeks,	8.96	67.9	13.5	2.38	56.5
After 8 weeks,	9.70	58.7	9.6	2.49	55.2
After 10 weeks,	7.72	56.1	9.2	2.48	56.4
After 12 weeks,	8.51	58.0	9.2	2.59	54.8

Organisms in Sludge.

Microscopic examinations were made every two weeks for seven months on samples of sludge from various settling tanks and filters. Paramæcium, Colpedium and Euplotes were the most numerous of the seventeen or more varieties found. Beggiatoa occurred in larger numbers in the sludge from slate Tank No. 449 than in any of the other sludges, and Vorticellæ grew best in the activated sludge tanks. The average number of organisms in regular sewage sludge was 70 per gram. After ten weeks' storage of sludge in Tank No. 483 this number increased to a maximum of 183. In a number of samples no organisms were found, and in the various aeration tanks the average numbers ranged from 385 to 740. There was no uniformity in the numbers or varieties found in any of the sludges.

The bacterial analyses of the sludges settled overnight are shown in the following table: —

Bacterial Analyses of Sludge.

SLUDGE FROM —	BACTERIA PER CUBIC CENTIMETER.		
	4 Days, 20° C.	24 HOURS, 37° C.	
		Total.	Red.
Settling Tank applied to Tank No. 483,	69,000,000	3,970,000	2,410,000
Slate Tank No. 449, bottom,	37,200,000	1,320,000	687,000
Activated Sludge Tank No. 465,	32,800,000	1,630,000	1,150,000
Activated Sludge Tank No. 482,	128,000,000	5,160,000	3,360,000
Activated Sludge Tank No. 484,	3,600,000	300,000	165,000
Tank No. 483: —			
After 2 weeks,	32,100,000	580,000	402,000
After 4 weeks,	28,100,000	500,000	375,000
After 6 weeks,	30,000,000	483,000	124,000
After 8 weeks,	26,100,000	343,000	110,000
After 10 weeks,	24,900,000	182,000	73,000
After 12 weeks,	20,550,000	240,000	85,000

Effect on Subsequent Filtration of Hypochlorite added to Sewage for Temporary Deodorization.

It was shown in the last report that 20 parts per 1,000,000 of available chlorine would deodorize sewage to which 5 per cent. of wool-scourings had been added. Experiments started last year and now complete show that if a sand filter has been in use some time and contains considerable stored organic matter, 40 parts per 1,000,000 available chlorine may be added day after day to the applied sewage without injury to the filter, as this chlorine is reduced by the organic matter. When, however, the layer of dirty sand is removed, this amount of chlorine quickly checks nitrification, and if continued long enough seriously damages the working of the filter. The 40 parts per 1,000,000 free chlorine practically sterilized the sewage used, but this did not interfere with nitrification. This is similar to the results in past experiments, when sewage sterilized by heat was successfully filtered by an unsterilized sand filter.

Filtration of Paper Mill Wastes.

The results obtained in 1915 on the treatment of wastes from a mill in the Neponset valley are given in the report for that year. The experiments were continued until August 1 of this year, and the following is a summary of the results for the whole period.

The wastes treated were from the washers, and averaged about 350,000 gallons daily. The raw stock used was largely old rope and cotton rags. The wastes were partially settled before being shipped to the station but were still very turbid and contained considerable sediment.

Two trickling filters Nos. 471 and 476, containing 7 feet in depth of crushed stone passing a 1-inch ring but retained by a ¼-inch ring, were started on July 1, 1915, at a rate of 500,000 gallons per acre daily. Filter No. 471 received the raw waste and Filter No. 476 the effluent from Filter No. 471, giving the effect of a 14-foot filter. On January 21 the rate of both was increased to 750,000 gallons per acre daily.

It was stated in the last report that there was reason to believe Filter No. 471 was becoming clogged. On March 14 it did become clogged, and the filter was emptied and refilled with coarser stone which would pass a 2-inch screen and be retained by a 1-inch screen. The effluent contained at this time more sediment and resembled that in sewage effluents. Probably the stone in Filter No. 476 would eventually have to be replaced with coarser.

Two sand filters, Nos. 478 and 479, containing 3½ feet in depth of sand of an effective size of 0.25 millimeter, were operated also with these wastes. Filter No. 478 refiltered the effluent from Filter No. 476 at a rate of 100,000 gallons per acre daily, and Filter No. 479 received at the same rate waste which had been precipitated by acid or alum. The effluents from all these filters were stable. Treatment of the waste with an average of 4,900 pounds of aluminum sulphate per 1,000,000 gallons gave a clear, supernatant liquid and considerable color removal. The effluents from the trickling filters were very much less turbid than the raw waste and the sediment was of such nature that it settled readily.

Average analyses are shown in the following tables: —

Average Analyses.

Settled Washer Wastes from a Paper Mill, applied to Filter No. 471.

[Parts in 100,000.]

AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	NITROGEN AS —		Oxygen consumed.	Fats.	Alkalinity.
Free.	ALBUMINOID.									
	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.			
.29	.92	.70	2.27	1.70	10.87	-	-	16.74	7.6	37.1

Average Analyses — Concluded.

Waste acidified, settled and made Alkaline, applied to Filter No. 479.

[Parts in 100,000.]

Ammonia.			Kjeldahl Nitrogen.		Chlorine.	Nitrogen as —		Oxygen consumed.	Fats.	Alkalinity.
Free.	Albuminoid.									
	Total.	In Solution.	Total.	In Solution.		Nitrates.	Nitrites.			
.30	.70	.61	1.79	1.42	-	-	-	12.40	-	—4.6[1]
Waste precipitated with Sulphate of Alumina (Average 4,900 Pounds per 1,000,000 Gallons).										
.32	.49	.42	1.24	1.04	-	-	-	6.01	-	9.6
Effluent from Filter No. 471.										
.12	.51	.35	1.22	-	-	.12	.0048	6.40	-	38.8
Effluent from Filter No. 476.										
.09	.28	.22	0.73	-	-	.64	.0101	4.09	-	30.2
Effluent from Filter No. 478.										
.10	.15	-	0.44	-	-	.77	.0069	2.66	-	25.2
Effluent from Filter No. 479.										
.41	.11	-	0.27	-	-	.45	.0015	1.59	-	14.9

[1] Before being made alkaline.

Average Solids.

Settled Washer Wastes from a Paper Mill, applied to Filter No. 471.

[Parts in 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
188.8	104.4	84.4	129.8	69.2	60.6	59.0	35.2	23.8
Waste precipitated with Sulphate of Alumina (Average 4,900 Pounds per 1,000,000 Gallons).								
124.7	51.2	73.5	119.7	48.6	71.1	5.0	2.6	2.4

TREATMENT OF TRADE WASTES WITH ACTIVATED SLUDGE.

Paper Mill Waste.

Sludge from the same waste as applied to Filter No. 471 was aerated continuously for several weeks until it settled readily and appeared to be activated.

Half-gallon bottles were about one-fifth filled with this sludge and with activated sewage-sludge. The bottles were then filled with waste of the same character as applied to Filter No. 471 and aerated continuously for twenty-three hours. Portions for analysis were withdrawn at the end of three and eight hours and settled one hour. The supernatant liquor in the bottles was removed after settling one hour and a portion saved for analysis. This experiment was continued daily for two months, but was stopped because the results were neither promising nor practical. Three hours' aeration reduced the Kjeldahl nitrogen 30 per cent. and the total suspended solids 55 per cent.; eight hours' aeration, 49 and 81 per cent., and twenty-three hours' aeration 57 and 78 per cent., respectively.

Tannery Waste.

Sludge from a tannery was aerated until it became stable and activated; then about 20 per cent. was mixed with liquid waste from the settling tanks at the tannery, the mixture aerated twenty-three hours, settled one hour and the supernatant liquor drawn off. This was repeated daily for about seven months. Average samples were taken for analysis after three, eight and twenty-three hours' aeration and one hour settling. Similar waste was simply settled one hour to show the difference between aeration and sedimentation and sedimentation alone.

The waste treated was high in nitrogenous matter and very putrescible, but even after three hours' aeration it was practically always stable although its improvement in appearance was not as great as would be expected from the increased stability. The reduction in suspended solids due to aeration varied from 3.3 to 6.3 parts in 100,000 for the different periods of aeration. The reduction of dissolved or colloidal organic matter was much greater, 19.1, 21.2 and 22.3 parts in 100,000, respectively, for three, eight and twenty-three hours' aeration, or over 40 per cent. At times the settled aerated waste was clear and dark straw-colored, and at other times nearly as turbid as the raw waste. Even when turbid the aerated waste was stable and as well nitrified as when clear. This turbid condition seemed to be caused by an unloading action of the sludge, as if when a certain amount of colloids had been precipitated there was a tendency for them to go back into the colloidal state again. The number of organisms in this sludge and in the paper mill sludge was fully as high as in any of the sewage-activated sludges.

Average Analyses.

Settled Waste as received from a Tannery and applied to Bottles containing Activated Sludge.

[Parts in 100,000.]

AMMONIA.			KJELDAHL NITROGEN.		Chlorine.	NITROGEN AS —		Oxygen consumed.	Alkalinity.
Free.	ALBUMINOID.		Total.	In Solution.		Nitrates.	Nitrites.		
	Total.	In Solution.							
3.25	.97	.57	2.31	1.23	41.7	–	–	14.00	29.4
Waste after One Hour Further Settling.									
3.24	.78	.57	1.87	1.23	–	–	–	11.40	28.4
Waste aerated Three Hours with Activated Tannery Sludge and settled One Hour.									
1.86	.43	.30	1.07	0.68	–	.20	.0524	5.37	19.8
Waste aerated Eight Hours with Activated Tannery Sludge and settled One Hour.									
1.41	.31	.22	0.90	0.56	–	.38	.0819	4.68	15.9
Waste aerated Twenty-three Hours with Activated Tannery Sludge and settled One Hour.									
0.50	.26	.17	0.74	0.45	–	.86	.0516	4.02	11.6

Average Solids.

Settled Waste as received from a Tannery and applied to Bottles containing Activated Sludge.

[Parts in 100,000.]

UNFILTERED.			FILTERED.			IN SUSPENSION.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
286.6	63.7	224.9	264.4	45.3	219.1	24.2	18.4	5.8

Average Solids — Concluded.

Waste after One Hour Further Settling.

[Parts in 100,000.]

Unfiltered.			Filtered.			In Suspension.		
Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.	Total.	Loss on Ignition.	Fixed.
276.0	55.6	220.4	264.4	45.3	219.1	11.6	10.3	1.3
Waste aerated Three Hours with Activated Tannery Sludge and settled One Hour.								
252.3	33.1	219.2	244.0	26.2	217.8	8.3	6.9	1.4
Waste aerated Eight Hours with Activated Tannery Sludge and settled One Hour.								
249.4	26.4	223.0	244.1	24.1	220.0	5.3	2.3	3.0
Waste aerated Twenty-three Hours with Activated Tannery Sludge and settled One Hour.								
247.7	24.5	223.2	242.2	23.0	219.2	5.5	1.5	4.0

OPERATION OF CONTACT FILTERS.

Contact filters at the station are operated largely to study the length of life of such filters and to illustrate to students, engineers, sewerage commissioners, etc., the construction and method of operation of this type.

Four such filters were in operation during the year. Filter No. 175, put into operation in 1901, is filled with coke of such size that all will pass a 1-inch screen, 75 per cent. a ½-inch screen, and practically none a ¼-inch screen. At the end of 1911 all the material was removed, washed and replaced. This filter has always received sewage that has been strained through coke or coal; it is flooded once daily and stands full two hours before draining, and is allowed to rest every sixth week. The effluent was stable throughout the year. The loss of open space was 30 per cent. at the end of the year, an increase in this loss of only 1 per cent. during 1916.

Filter No. 425 is one of a series of eight filters started on Jan. 4, 1911, to study the effect of different methods of operation, and contains 33 inches in depth of clinker having a diameter between ¼ and 1¼ inches. When this study was finished in 1915 Filter No. 425 was continued in operation to make with Filter No. 443 a double contact system. It is filled twice daily and allowed to stand one hour before draining. The loss of open space at the end of the year was 44 per cent., an increase for the year of 8 per cent.

Double Contact Filtration.

Filter No. 443, containing 21 inches in depth of broken stone pebbles all of which will pass a ½-inch screen, 43 per cent. a ¼-inch screen and practically none a ⅛-inch screen, was started on April 21, 1912, to study the effect of passing settled Lawrence sewage through two successive contact filters. During the year 96 per cent. of the samples from the primary filter and all of the samples from the secondary filter were stable. The loss of open space at the end of the year was 36 per cent., an increase of 4 per cent.

Contact Filtration of Sewage clarified by Aeration.

Filter No. 456, constructed of 3 feet in depth of clinker passing a 1-inch screen and held back by a ½-inch screen, was started on Jan. 1, 1914, to study the operation of contact filters with sewage clarified in slate aeration tanks. It was flooded three times daily throughout the year, and the loss of open space was 33 per cent., an increase of 11 per cent. during the year.

After an equal time of operation, Filter No. 426, described in previous reports, which was also filled three times daily but allowed to rest every sixth week, lost 66 per cent. of its open space. One hundred per cent. of the samples from Filter No. 456 were stable, and the effluent was of a better quality than that from Filter No. 426.

Average Analyses.

Effluent from Filter No. 175.

[Parts in 100,000.]

Quantity applied. — Gallons per Acre Daily.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as —		Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
				Albuminoid.								
	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.			
450,800	1.0	.39	.2802	.1063	.0670	.28	3.71	1.46	.0083	0.71	3.8	480,000

Effluent from Filter No. 425.

521,200	2.6	.52	.6967	.1882	.1230	.40	4.10	0.82	.0109	1.45	5.4	156,000

Average Analyses — Concluded.

Effluent from Filter No. 443.

[Parts in 100,000.]

Quantity applied.	Appearance.		Ammonia.			Kjeldahl Nitrogen.	Chlorine.	Nitrogen as —		Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
				Albuminoid.								
Gallons per Acre Daily.	Turbidity.	Color.	Free.	Total.	In Solution.			Nitrates.	Nitrites.			
522,000	2.2	.42	.3409	.1363	.0913	.33	4.00	1.29	.0074	1.21	2.8	530,000

Effluent from Filter No. 456.

1,184,800	2.3	.63	.9469	.1091	.0742	.26	3.58	0.87	.0053	0.80	6.0	341,000

INTERMITTENT SAND FILTERS OPERATED WITH UNTREATED SEWAGE.

Filters Nos. 1, 2, 4, 6 and 9A.

Each of these five sand filters is $\frac{1}{200}$ of an acre in area, and at the end of the year Filters Nos. 1, 2, 4 and 6 had been operated continuously for nearly twenty-nine years, and Filter No. 9A had been operated twenty-six years. These filters are kept in operation to demonstrate the permanency of such filters when under good management. Regular station sewage without preliminary clarification has always been applied to these filters and for some years it has been the practice to apply only as much sewage to each filter as can be purified without increasing the amount of organic matter stored within the filter. Since 1893, a period of about twenty-three years, all of these filters have been operated without the removal of any sand from the surface.

The depth and size of sand of which each filter is constructed, the date when first put into operation, the total volume of sewage treated upon each filter since it was started, and the volume of sewage applied daily during the year are shown in the following table: —

FILTER NUMBER.	Depth (Feet).	Effective Size of Sand (Millimeter).	Date first operated.	Actual Volume of Sewage applied since Start (Gallons).	Volume of Sewage applied Daily during 1916 (Gallons per Acre.)
1, ...	5	.48	Dec. 10, 1888	2,883,896	45,900
2,[1]	5	.08	Dec. 19, 1887	1,645,851	35,600
4, ...	5	.04	Dec. 19, 1887	991,196	19,200
6,[1]	3⅔	.35	Jan. 12, 1888	2,345,982	44,000
9A, ...	5	.17	Nov. 18, 1890	2,370,857	46,000

[1] Discontinued Nov. 30, 1916.

For a number of years the surfaces of Filters Nos. 1, 6 and 9A have been leveled during the summer but have been trenched and ridged during the winter. The surfaces of Filters Nos. 2 and 4 are arranged in circular trenches which are filled with coarser sand than that of which the filters are constructed. The trenches in Filter No. 2 are 1 foot wide and 2 feet deep, and are filled with sand of an effective size of 0.19 millimeter, while those in Filter No. 4 are about 14 inches wide and 1 foot deep, and are filled with sand of an effective size of 0.48 millimeter, the surface of the sand in the trenches of each filter being below that of the remainder of the filter. The sewage is applied to these trenches of coarser sand throughout the year, grass being permitted to grow on the ridges. During the year the surface of the filters was dug over to a depth of from 8 to 10 inches twice and raked to a depth of 2 inches on ten different occasions. Board coverings were put over the trenches early in December and removed in May as usual.

An examination of the sands in Filters Nos. 1, 6 and 9A is made about the first of July each year. As has been previously stated, the greater part of the stored organic matter is in the first foot of sand. Following tables show analyses for the past nine years, and analyses of the sand in Filters Nos. 2 and 6 when discontinued at the end of the year. There has been a slight accumulation of organic matter in Filter No. 1 and a reduction in Filters Nos. 6 and 9A, so that there is less organic matter held by the sand at the present time than in any of the four preceding years.

The average analyses of the effluents from these filters are shown in the following tables: —

Average Analyses.

Effluent from Filter No. 1.

[Parts in 100,000.]

Quantity applied. Gallons per Acre Daily for Six Days in a Week.	TEMPERATURE (DEGREES F.).		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen consumed.	Alkalinity.
	Sewage.	Effluent.	Free.	Albuminoid.		Nitrates.	Nitrites.		
45,900	58	55	.1050	.0252	3.95	1.85	.0003	.26	—0.5
Effluent from Filter No. 2.									
35,600	58	53	.0123	.0119	3.63	1.78	.0002	.15	—0.2
Effluent from Filter No. 4.									
19,200	56	53	.0036	.0102	3.48	1.61	.0001	.10	0.2
Effluent from Filter No. 6.									
44,000	58	55	.0808	.0230	3.63	1.92	.0006	.23	—0.3
Effluent from Filter No. 9A.									
46,000	58	55	.0422	.0179	3.66	1.85	.0001	.26	—0.1

Sand Analyses.

Albuminoid Ammonia in First Foot of Sand in Filters Nos. 1, 6 and 9A.

[Parts in 100,000.]

YEAR.	Filter No. 1.	Filter No. 6.	Filter No. 9A.
1908,	57.9	61.0	69.2
1909,	52.7	53.8	69.3
1910,	66.1	69.3	56.5
1911,	45.6	63.3	65.1
1912,	74.0	108.0	83.9
1913,	77.3	91.2	74.8
1914,	95.2	106.7	76.0
1915,	74.9	111.7	81.1
1916,	80.8	76.0	70.0

Analyses of Sands in Filters Nos. 2 and 6 when put out of Operation on Nov. 30, 1916.

[Parts in 100,000.]

Depth (Inches).	Filter No. 2 under Trench.		Filter No. 2 under Ridge.		Filter No. 6.	
	Free Ammonia.	Albuminoid Ammonia.	Free Ammonia.	Albuminoid Ammonia.	Free Ammonia.	Albuminoid Ammonia.
6,	2.43	137.0	2.32	101.7	1.10	127.3
12,	1.33	61.1	0.80	53.7	0.74	53.0
18,	1.14	57.9	0.76	31.4	0.36	21.7
24,	0.43	7.2	0.29	7.7	0.24	8.1
36,	0.24	2.8	–	–	0.23	4.9
48,	0.20	2.2	–	–	0.16	2.1
54,	–	–	–	–	0.16	2.5
60,	0.26	2.1	–	–	–	–

INTERMITTENT SAND FILTERS OPERATED WITH CLARIFIED SEWAGE.

Filters Nos. 429, 430, 431 and 432.

These four filters were first put into operation on Feb. 1, 1911, to study the results obtained from a series of filters receiving sewages of different strength, but at such rates in gallons per acre daily that the amount of organic matter applied to each was practically the same. Each of these filters is $\frac{1}{20000}$ of an acre in area, and is constructed of 5 feet in depth of sand of an effective size of 0.25 millimeter over the usual underdrains. Regular station sewage has been applied to Filter No. 429 at a rate of 80,000 gallons per acre daily. Each of the other filters has received the same sewage after a portion of the organic matters has been removed, — Filter No. 430 receiving settled sewage, Filter No. 431 receiving the effluent from coal Strainer E, and Filter No. 432 receiving sewage which has been clarified by precipitation with sulphate of alumina, — the volume of clarified sewage applied to each of these filters being so adjusted that the amount of organic matter applied to each should be approximately the same as that applied to Filter No. 429, which received the unclarified sewage. Kjeldahl nitrogen has been used as a measure of the organic matter in computing the rates of the filters receiving clarified sewage, and those rates have been fluctuated from time to time as the nitrogen of the different sewages has varied.

The average rates and analyses of the effluents from these filters are shown in a following table. The analyses of the sewage applied will not be given again, as they are practically the same as those given for regular sewage, settled sewage, Strainer E and chemically precipitated sewage in the first part of this report.

The amount of organic nitrogen, expressed in pounds per acre, applied to Filter No. 429 during the year was 1,872 pounds, and the amount since the start of the filter in 1911 has been 12,197 pounds. The amounts applied to Filters Nos. 430, 431 and 432 since the beginning of the experiment have been 70 pounds more and 19 and 130 pounds less, respectively, than that applied to Filter No. 429.

There has been only a slight accumulation of organic matter in the different filters during the year, as shown by the determination of albuminoid ammonia in the sands, and most of the increase has been in the upper portion. The accumulation is best shown by giving the average albuminoid ammonia in the whole depth of the filters at the end of each year of operation, and such determinations are shown in the following table: —

Average Albuminoid Ammonia in Sands at End of Year.

[Parts in 100,000.]

YEAR.	Filter No. 429.	Filter No. 430.	Filter No. 431.	Filter No. 432.
1911,	7.8	8.2	8.1	7.3
1912,	17.3	14.3	15.8	16.5
1913,	19.6	19.6	18.0	16.6
1914,	20.6	19.6	16.6	19.4
1915,	26.3	20.7	25.5	26.0
1916,	22.3	24.4	30.7	22.5

Average Analyses.

Effluent from Filter No. 429.

[Parts in 100,000.]

Quantity applied. — Gallons per Acre Daily.	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen consumed.	Alkalinity.	Bacteria per Cubic Centimeter.
	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.			
78,800	0.1—	.09	.0365	.0137	3.73	1.86	.0001	.15	0.1	920

Effluent from Filter No. 430.

132,000	0.1—	.13	.0320	.0196	4.17	1.85	.0002	.22	0.2	1,300

Effluent from Filter No. 431.[1]

150,500	0.1—	.12	.0153	.0136	3.38	1.51	.0005	.14	0.4	7,400

Effluent from Filter No. 432.

125,300	0.0	.12	.1265	.0240	3.38	1.51	.0007	.20	—0.8	240

[1] Discontinued Nov. 30, 1916.

PURIFICATION OF WATER.

LAWRENCE CITY FILTERS.

The source of the water supply of the city of Lawrence is the Merrimack River. Two filters are in use to purify this water. The older filter was constructed in 1893, and dividing walls separating it into three sections were built in 1902. This filter contains about 4 feet in depth of sand of an effective size of approximately 0.25 millimeter. It is not covered, and two sections have an earth bottom through which some ground water finds its way into the underdrains and becomes mixed with the filtered water. A concrete bottom is being put in the third section. The average rate of operation during the past few years has been about 1,000,000 gallons per acre daily.

In November, 1907, a modern covered filter of concrete construction was put into operation to supplement the supply of filtered water from the old filter. This filter is three-quarters of an acre in area and contains about 4½ feet in depth of sand of an effective size of 0.25 millimeter. The average rate of operation during the year was about 3,000,000 gallons per acre daily. The effluents from both of these filters flow into the same pump-well, from which they are pumped into the distributing reservoir. The difference in the degree of purification produced by these two filters is shown by the average analyses in the tables beyond. While repairs were being made on one section of the old filter a certain amount of water from the Andover and North Andover systems was pumped into the Lawrence mains. Probably some of this water was present in some of the samples taken from the tap at the Lawrence Experiment Station. As has been the case for the last few years, the effluent from the older filter was better bacterially than that from the covered filter, which is operated at a much higher rate.

The average analyses of the effluents from these filters, and of the samples from other points on the Lawrence water supply system, are shown in the following tables.

Average Chemical Analyses.

Merrimack River. — Intake of the Lawrence City Filters.

[Parts in 100,000.]

Temperature (Degrees F.).	APPEARANCE.		AMMONIA.			Chlorine.	NITROGEN AS —		Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
				ALBUMINOID.								
	Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.				
47	0.3	.45	.0128	.0183	.0136	.39	.0118	.0003	.56	.0526	1.3	1.4

Effluent from Lawrence City Filter (Old Filter).

Temperature (Degrees F.).	Turbidity.	Color.	Free.	Albuminoid Total.	Albuminoid In Solution.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
50	0.2	.41	.0113	.0074	–	.43	.038	.0002	.38	.1063	1.5	1.6

Effluent from Lawrence City Filter (New Filter).

Temperature (Degrees F.).	Turbidity.	Color.	Free.	Albuminoid Total.	Albuminoid In Solution.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
49	0.1–	.35	.0031	.0074	–	.37	.044	.0002	.40	.0210	1.2	1.3

Water from the Outlet of the Distributing Reservoir.

Temperature (Degrees F.).	Turbidity.	Color.	Free.	Albuminoid Total.	Albuminoid In Solution.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
47	0.1	.42	.0076	.0081	–	.38	.034	.0001	.34	.0707	1.5	1.6

Water from a Tap at Lawrence City Hall.

Temperature (Degrees F.).	Turbidity.	Color.	Free.	Albuminoid Total.	Albuminoid In Solution.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
50	0.1	.43	.0057	.0078	–	.39	.037	.0001	.34	.0720	1.5	1.6

Water from a Tap at the Lawrence Experiment Station.

Temperature (Degrees F.).	Turbidity.	Color.	Free.	Albuminoid Total.	Albuminoid In Solution.	Chlorine.	Nitrates.	Nitrites.	Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
53	0.1	.36	.0038	.0096	–	.41	.031	.0001	.28	.0640	1.4	1.5

Average Bacterial Analyses.

Merrimack River. — Intake of the Lawrence City Filters.

BACTERIA PER CUBIC CENTIMETER.			PER CENT. OF BACTERIA REMOVED.			PER CENT. OF SAMPLES CONTAINING B. COLI.	
20° C.	37° C.		20° C.	37° C.			
	Total.	Red.		Total.	Red.	1 c. c.	100 c. c.
7,000	870	310	–	–	–	–	–

Average Bacterial Analyses — Concluded.

Effluent from the Lawrence City Filter (Old Filter).

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.	
20° C.	37° C.		20° C.	37° C.			
	Total.	Red.		Total.	Red.	1 c. c.	100 c. c.
21	7	2	99.4	99.2	99.5	15	34
Effluent from the Lawrence City Filter (New Filter).							
21	6	2	99.5	98.6	99.3	25	58
Mixed Effluents as pumped to Distributing Reservoir.							
29	8	2	-	-	-	20	52
Water from Outlet of the Distributing Reservoir.							
59	7	1	-	-	-	10	51
Water from a Tap at Lawrence City Hall.							
43	5	1	-	-	-	6	34
Water from a Tap at the Lawrence Experiment Station.							
55	8	1	-	-	-	7	39

REFILTRATION OF LAWRENCE CITY WATER.

Filter No. 343A, $\frac{1}{20000}$ of an acre in area, was started in 1908. At the beginning of 1916 the depth of sand was 34 inches of an effective size of 0.35 millimeter. Since July, 1913, water from the city mains has been applied at a rate of 5,000,000 gallons per acre daily.

The water as applied to the filter is aerated by falling about 2 feet on to a plate, increasing the per cent. saturation of dissolved oxygen by about 4 per cent. Scraping seven times during the year was necessary to maintain the rate. This amount of scraping approximates that required in the filtration of raw river water, and is made necessary largely by the iron rust from the water mains. The average color removed was 31 per cent., 10 per cent. higher than last year, and the per cent. reduction of iron was 66 per cent., nearly the same as last year.

The new city filter, with a larger proportion of the iron in solution in the applied water, removed 60 per cent. of the iron. Considering this it is rather remarkable that Filter No. 343A, even though running at a 2,000,000-gallon higher rate, should still leave more iron in the effluent than the new city filter.

Average Analyses.

City Water applied to Filter No. 343A.

[Parts in 100,000.]

Quantity applied. — Gallons per Acre.	APPEARANCE.		AMMONIA.		Chlorine.	NITROGEN AS —		Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
	Turbidity.	Color.	Free.	Total Albuminoid.		Nitrates.	Nitrites.				
-	0.1	.45	.0040	.0089	.46	.030	.0000	.32	.0873	1.5	1.6

Effluent from Filter No. 343A.

4,715,000	0.0	.31	.0029	.0060	.45	.034	.0000	.23	.0300	1.4	1.5

SAND FILTERS OPERATED WITH MERRIMACK RIVER WATER AT DIFFERENT RATES.

Filters Nos. 417 and 419 have been operated since December, 1910, as part of a study of the effect of the rate of filtration upon the hygienic efficiency and economy of operation of slow sand filters. At the beginning of the year these two filters contained 48 and 33 inches in depth of sand, respectively, of an effective size of 0.25 millimeter. Merrimack River water was applied to both at intended rates of 2,500,000 and 10,000,000 gallons, respectively, although owing to frequent clogging the average rate for Filter No. 419 was only 7,000,000 gallons per acre daily.

The bacterial efficiency of Filter No. 417 has always been higher than that of Filter No. 419, as would be expected from the lower rate. Chemically, the albuminoid ammonia and iron are slightly higher in the latter effluent. The average per cent. saturation of dissolved oxygen in the effluent from the two filters has been 23.9 and 28.6, respectively. Both reduced the color of the water 24 per cent. Filter

No. 417 was raked once and scraped four times during the year. Filter No. 419 was raked seven times and scraped eleven times, and even then ran at less than three-quarters of the intended rate. This filter gave a great deal of trouble from becoming air-bound. At a 10,000,000-gallon rate the loss of head was rapid after starting the filter, and the reduced pressure inside the filter probably brought dissolved oxygen and nitrogen out of the water. The chemical and bacterial analyses are shown in the following table: —

Average Chemical Analyses.

Merrimack River (Canal) Water applied to Experimental Filters.

[Parts in 100,000.]

Temperature (Degrees F.).	Quantity applied. — Gallons per Acre.	Appearance.		Ammonia.			Chlorine.	Nitrogen as —		Oxygen consumed.	Iron.	Alkalinity.	Soap Hardness.
					Albuminoid.								
		Turbidity.	Color.	Free.	Total.	In Solution.		Nitrates.	Nitrites.				
51	-	0.2	.46	.0106	.0144	.0120	.34	.019	.0001	.50	.0463	1.1	1.2
Effluent from Roughing Filter No. 389A.													
51	9,377,000	0.0	.37	.0026	.0085	-	.35	.030	.0000	.39	.0502	1.0	1.2
Effluent from Slow Sand Filter No. 417.													
51	2,535,000	0.0	.35	.0022	.0063	-	.34	.029	.0001	.34	.0300	1.1	1.2
Effluent from Slow Sand Filter No. 419.													
52	7,182,000	0.0	.36	.0030	.0077	-	.34	.030	.0001	.34	.0370	1.1	1.2

Average Bacterial Analyses.

Merrimack River (Canal) Water applied to Experimental Filters.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	37° C.		20° C.	37° C.		1 Cubic Centimeter.
	Total.	Red.		Total.	Red.	
2,800	230	110	-	-	-	-

Average Bacterial Analyses — Concluded.

Bacteria per Cubic Centimeter.			Per Cent. of Bacteria removed.			Per Cent. of Samples containing B. Coli.
20° C.	37° C.		20° C.	37° C.		1 Cubic Centimeter.
	Total.	Red.		Total.	Red.	
Effluent from Slow Sand Filter No. 343A.						
20	3	0	63	62	100	1
Effluent from Roughing Filter No. 389A.						
140	20	7	94	91	94	53
Effluent from Slow Sand Filter No. 417.						
34	6	1	98	97	99	11
Effluent from Slow Sand Filter No. 419.						
120	15	6	95	93	94	57

Preliminary Filtration through Coarse Material.

Filter No. 389A was rebuilt on Dec. 6, 1913, and now contains 60 inches in depth of broken stone pebbles, of an effective size of 4.4 millimeters over a $\frac{1}{8}$-inch copper screen raised 1 inch from the bottom. During the year the surface was raked once and washed five times. The surface layer and probably all the pebbles are covered with a gelatinous deposit. It is probably this deposit that is responsible for the high bacterial efficiency and chemical purification of such coarse filtering material. The reduction of color was 20 per cent., but the iron was increased.

DIVISION OF FOOD AND DRUGS.

HERMANN C. LYTHGOE, *Director and Analyst.*

REPORT OF DIVISION OF FOOD AND DRUGS.

The Food and Drug Division of the Massachusetts State Department of Health has been engaged during the year in the usual activities required for the enforcement of the various laws regarding the purity of our food products and drugs. The Division is operating in a very satisfactory manner, as most of the administrative difficulties have been overcome and the employees have been doing their work in an efficient manner. Very little research work relating to foods has been carried out, owing to the research work in organic chemistry assumed by the Division, due to the passage of the resolve of the Legislature of 1916, authorizing the Department to manufacture a substance which could be used in the prevention of the transmission of syphilis. This work has necessarily been carried on in the crowded quarters of the Division originally designed for two chemists and now occupied by six chemists and four clerks. The room formerly used as a library is now an office; there are but two desks available for the five assistants; the laboratory bench room is but half what should be available for the present needs of the Division, and the laboratory floor is used for storage because of lack of storage rooms. It is practically impossible to increase the number of samples examined because of lack of space.

The expense of travel to the western part of the State is very large. This could be reduced somewhat by establishing a laboratory in the Connecticut River Valley with a resident chemist and inspector. The necessity of more frequent visits to this portion of the State is becoming apparent, and it is possible that this laboratory could be utilized and partly supported by some of the other divisions. In order to more thoroughly do the necessary work in parts of the State not readily accessible to Boston, the traveling laboratory mentioned in the report of 1915 was utilized to a greater extent than before. In addition to the resulting increase in field work the laboratory congestion was relieved to some extent during a period of one month while the chemists were away upon these trips. In this way a large portion of Berkshire, Barnstable, Dukes and Nantucket counties was covered.

The personnel of the Division, with the exception of one clerk, has not changed, and is as follows: —

Director of Division and Chief Analyst.

Hermann C. Lythgoe, S.B.

Assistant Analysts.

Charles H. Hickey, S.B.
Lewis I. Nurenberg, S.B.
Clarence E. Marsh, A.B.
Katherine E. Rooney, S.B.

Inspectors assigned to Enforcement of Cold-storage Laws.

Towneley T. French, M.D.
John F. McDonough.

Inspectors assigned to Enforcement of Milk, Food and Drug Laws.

Daniel E. McCarthy.
Frederick L. Marion.
Maurice P. Crowe.
James S. Kenneally.

Inspectors assigned to Enforcement of Slaughtering Laws.

Alvord H. Rose, D.V.S.
James M. Kingston, V.M.D.
George L. Drury, D.V.M.

Clerical.

Celeste E. Macaulay.
Ermyn E. Schumann.
Eleanor J. Brogan.

The following cities and towns have been visited by the various inspectors and analysts. Those localities where samples were taken for analysis are designated A, those where the inspectors visited relative to cold storage are designated C, those where dairies were inspected are designated D, those where lectures were given are designated L, those where courts were visited to institute prosecutions are designated P, and those where the veterinary inspectors investigated the operation of the slaughtering laws are designated S.

Abington (A, P, S); Acton (A, S); Acushnet (S); Adams (A, S); Agawam (S); Alford (S); Amesbury (A, S, P); Andover (A, S); Arlington (A, S); Ashby (S); Ashland (S); Athol (A, P, S); Attleboro (A, D, P); Auburn (L, S); Avon (S); Ayer (S); Barnstable (A, C, S, P); Barre (A); Bedford (A, S); Belchertown (S); Belmont (A, D); Berkley (A); Berlin (S); Bernardston (S); Beverly (A, L, S); Billerica (S); Blackstone (A, P, S); Boston (A, C, L, P, S); Bourne (A, L); Boxford (S); Boylston (S); Braintree (A, S); Brewster (A); Bridgewater (A, S); Brimfield (S); Brockton (A, C, P, S); Brookfield (S); Brookline (A, P, C); Cambridge (A, C, S, P); Canton (A, S); Carlisle (A, S); Carver (S); Charlton (S); Chatham (A); Chelmsford

(A, S); Chelsea (A, P, S, C); Cheshire (D, S); Chicopee (A, C, D, S); Clarksburg (S); Clinton (A, P, S); Cohasset (A, S); Colrain (S); Concord (A, P, S); Dalton (A); Danvers (A, S); Dartmouth (D, S); Dedham (A, P, S); Deerfield (S); Dennis (A); Dover (A, S); Dracut (S); Dudley (A, D, S); Duxbury (S); East Bridgewater (A, S); East Brookfield (P); Easthampton (S); Easton (A, S); Edgartown (A); Egremont (S); Enfield (S); Essex (A, S); Everett (A, C, P); Fairhaven (A, P, S); Fall River (A, P, S); Falmouth (A, S); Fitchburg (A, P, S); Foxborough (S); Framingham (A, P, S); Franklin (A, S); Gardner (A, P, S); Gay Head (S); Gloucester (A, C, S); Grafton (A, D, S); Great Barrington (A, P, S); Greenfield (A, L, P, S); Groton (A, S); Halifax (S); Hamilton (D); Hancock (S); Hanson (S); Hardwick (A); Harvard (S); Haverhill (A, C, P, S); Hingham (A, P, S); Hinsdale (A); Holbrook (D, S); Holden (S); Holliston (A, S); Holyoke (A, P); Hopedale (S); Hopkinton (S); Hudson (A, S); Lanesborough (D, S); Lawrence (A, C, P, S); Lee (A, P, S); Lenox (A); Leominster (A, S); Lexington (A, S); Lincoln (A, S); Littleton (A, S); Lowell (A, C, P, S); Ludlow (A, S); Lynn (A, C, P, S); Lynnfield (S); Malden (A, C, P, S); Manchester (A); Mansfield (A, S); Marblehead (A, C, S); Marlborough (A, P, S); Mattapoisett (D); Maynard (A, S); Medfield (S); Medford (A); Medway (S); Melrose (A, L, S); Mendon (A, D); Merrimac (S); Methuen (A, L, S); Middleborough (A, P, S); Middleton (S); Milford (A, C, P, S); Millbury (A); Millis (S); Milton (A, S); Montague (A, S); Nantucket (A, S); Natick (A, C, S); Needham (A, S); New Bedford (A, C, P, S); New Braintree (S); Newbury (S); Newburyport (A, P, S); Newton (A, P, S); Norfolk (S); North Adams (A, C, S); North Attleborough (A, S); North Brookfield (A, D, S); North Easton (S); North Reading (S); Northampton (A, P, S); Northbridge (A, S); Northfield (S); Norton (S); Norwell (A); Norwood (A, S); Oak Bluffs (A); Oakham (S); Orange (A, S); Otis (S); Oxford (S); Palmer (A, S); Paxton (S); Peabody (A, S); Pepperell (A, S); Pittsfield (A, C, D, P, S); Plymouth (A, P, S); Provincetown (A, C, P); Quincy (A, P, S); Randolph (A, S); Raynham (S); Reading (A, S); Rehoboth (S); Revere (A, S); Richmond (A); Rochester (S); Rockland (S); Rockport (A, S); Rowley (S); Royalston (S); Rutland (S); Salem (A, C, L, P, S); Salisbury (A); Sandisfield (S); Sandwich (A); Saugus (A, S); Scituate (A, S); Seekonk (S); Sharon (A, S); Shelburne (S); Sherborn (S); Shirley (L, S); Shrewsbury (S); Somerville (A, C, P, S); South Hadley (C); Southampton (S); Southbridge (A); Spencer (A); Springfield (A, C, L, P, S); Sterling (A, S); Stockbridge (S); Stoneham (A); Stoughton (A, P, S);

Stow (S); Sturbridge (S); Sudbury (S); Sunderland (S); Sutton (S); Swampscott (A, S); Taunton (A, C, P, S); Tewksbury (A, S); Tisbury (C); Topsfield (S); Truro (A, C); Tyngsborough (A, S); Tyringham (S); Upton (S); Uxbridge (A, S); Wakefield (A, S); Walpole (A, L, S); Waltham (A, C, P, S); Ware (S); Wareham (A, P); Warren (A); Watertown (A, S); Wayland (S); Webster (A, P, D); Wellesley (A); Wellfleet (S); Wenham (S); West Bridgewater (S); West Brookfield (S); West Springfield (A); West Stockbridge (S); West Tisbury (S); Westborough (A, S); Westfield (S); Westford (A, S); Weston (A, S); Westport (S); Westwood (S); Weymouth (A, S); Whitman (A, S); Williamstown (A); Wilmington (S); Winchendon (A, S); Winchester (A, S); Winthrop (A); Woburn (A, C, P, S); Worcester (A, C, P, S); Wrentham (L); Yarmouth (A).

In addition to the above places the following places out of the State were visited: Salem, N. H., Pelham, N. H., Rindge, N. H., Little Compton, R. I., and Thompson, Conn.

In a number of instances local boards of health or their employees have requested and received assistance from the Food and Drug Division. It is hoped that this list will be increased in the future. In a number of instances local boards of health or their employees have rendered valuable assistance to the Food and Drug Division. This is particularly true of the board of health of Holyoke, which permitted the assistants of this Division use of their laboratory for several days during the National Dairy Show in September, 1916. These localities are as follows: —

Asking and securing assistance from the Food and Drug Division: Attleboro, Arlington, Boston, Chicopee, Dudley, Fairhaven, Haverhill, Holbrook, North Brookfield, North Reading, Pittsfield, Somerville, Wakefield, Webster.

Giving assistance to the Food and Drug Division: Attleboro, Barnstable, Fall River, Fitchburg, Holyoke, Lowell, Lynn, Natick, Revere, Salem and Wareham.

Summary of Cities and Towns visited.

Total places visited (5 extrastate),	259
Places where samples were collected,	156
Places visited relative to slaughtering,	203
Places visited relative to cold storage,	32
Places where local inspectors were seen,	117
Places where dairies were inspected,	14

The amount of work done is materially greater than that of previous years. The samples collected and examined were 932 more than in 1915; the number of prosecutions were 23 less, but the amount of fines imposed was $3,681.72 more than in 1915; and the number of confiscations was 28,639 pounds more than in 1915. The following table gives the summary of these figures for the past three years: —

	1914.	1915.	1916.
Milk samples,	6,008	7,234	7,958
Food samples, including those taken from cold storage,	1,975	1,855	2,330
Drug samples,	1,790	1,141	874
Samples submitted by police authorities,	339	426	253
Totals,	10,112	10,656	11,415
Court cases,	258	273	250
Fines imposed,	$3,413 60	$4,340 08	$8,021 80
Total weight of confiscated articles (pounds),	53,182½	96,761½	125,400½

There were 250 cases brought before the courts for violation of the laws enforced by the Department. Of these cases, 20 were discharged, and 1 each defaulted, nol-prossed and dismissed for want of prosecution. The following table gives a summary of the cases disposed of. The names of the persons convicted for violation of the milk, food and drugs laws will be found in House Bill No. 1613. For the names of persons convicted for violation of the cold-storage and slaughtering laws, see Monthly Bulletins of the State Department of Health for 1916.

Summary of Prosecutions.

OFFENCE.	Cases.	Convicted.	Discharged.	Dismissed for Want of Prosecution.	Nol-prossed.	Defaulted.
Sale of low-standard milk,	5	4	1	-	-	-
Sale of skimmed milk as pure milk,	15	14	1	-	-	-
Sale of watered milk,	37	36	1	-	-	-
Sale of dirty milk,	6	4	2	-	-	-
Sale of low-standard cream,	1	1	-	-	-	-
Sale of low-standard ice cream,	2	2	-	-	-	-
Misuse of milk bottle,	1	1	-	-	-	-
Sale of food containing preservatives,	27	26	-	1	-	-

Summary of Prosecutions — Concluded.

Offence.	Cases.	Convicted.	Discharged.	Dismissed for Want of Prosecution.	Nol-prossed.	Defaulted.
Sale of adulterated maple sugar,	12	12	-	-	-	-
Sale of adulterated olive oil,	1	1	-	-	-	-
Sale of adulterated sausages,	26	23	3	-	-	-
Sale of adulterated scallops,	4	3	1	-	-	-
Sale of adulterated flavoring extracts,	2	2	-	-	-	-
Sale of decomposed eggs,	34	27	6	-	-	1
Sale of decomposed meat,	2	2	-	-	-	-
Sale of decomposed fish,	2	2	-	-	-	-
Sale of adulterated drugs,	16	15	1	-	-	-
Refusing to sell to inspector,	3	3	-	-	-	-
Operating unlicensed cold-storage warehouse,	1	1	-	-	-	-
Failure to file report of warehouse,	2	-	2	-	-	-
Placing decomposed food in cold storage,	1	-	1	-	-	-
Unlawfully holding food in cold storage longer than twelve months.	7	4	3	-	-	-
Unlawfully returning goods to cold storage,	1	-	-	-	1	-
Violation of cold-storage labeling laws,	3	3	-	-	-	-
Relative to slaughtering in the absence of the inspector,	16	12	4	-	-	-
Relative to sale of uninspected meat,	10	9	1	-	-	-
Selling light-weight veal,	1	1	-	-	-	-
Selling meat of cow which had died,	1	1	-	-	-	-
Unlawful use of stamp, etc.,	2	2	-	-	-	-
Neglect of inspector to comply with rules and regulations, and to comply with law.	7	6	1	-	-	-
Violation of mattress law,	2	2	-	-	-	-
Totals,	250	219	28	1	1	1

A number of these cases deserve special comment. Six cases relative to the cold storage of food were discharged, in four instances because of technical defects in the law; one case was for placing in cold storage eggs "deemed by the State Department of Health to be decomposed." The court held that the "deeming" must take place before the articles are placed in cold storage. Three cases were lost for holding food in cold storage longer than twelve months without the consent of the State Department of Health. In these instances the goods were sold while in storage, and none of the owners during this period had actually controlled the storage for twelve months. The cases against the egg breakers for violation of the egg law were first brought against the corporations. It soon developed that these corporations intended to dissolve after the trial in the lower court, and before the cases could be tried in the Superior Court. One corporation actually went out of business before the cases were tried in the lower court. By advice of the district attorney cases were brought against the officers of the corporations for violation of the egg law. As the trial of these cases brought up many questions involving corporation law, counsel was obtained and conviction secured in all cases. The case of a "dead" cow being sold for food is noteworthy in that we were able to obtain the evidence. This form of offence is not at all uncommon. If the carcass is found by the inspector of this Department it is confiscated. When boned and transformed into sausages the chain of evidence is lost.

The evidence in a case involving the sale of decomposed meat was obtained in an unusual manner. A call over the telephone was received asking that an inspector be sent to a certain sausage factory to confiscate some meat in order that it might be sent to the rendering works. The purchaser of the meat, when he ascertained it was unfit for food, complained to the slaughterer and was told by the latter to ship it to the rendering works. The purchaser asked if it was not necessary to have the meat condemned by the board of health before the renderer could take it. The slaughterer said by no means to go to the board of health. The purchaser stated to this Department that he had been recently fined for violation of the sausage law and proposed to take no more chances. His request was complied with, the meat was confiscated after samples were taken, and the seller was convicted and fined for violation of the food law.

Parke, Davis & Co. sold to the Riker-Jaynes Company some bacillus bulgaricus tablets which, upon analysis, were found to contain no bulgaricus bacilli in some instances, and in others were found to contain other bacteria. These tablets, according to the Riker-Jaynes Company, were obtained from the Boston store of Parke, Davis & Co. In order to obtain a case more directly an inspector of this Department attempted to purchase some of these tablets at the Boston office of Parke, Davis & Co. without success. He then made known his identity, tendered some money, read the law to the clerks and demanded that they make sales. This the clerks refused to do. Both clerks and the corporation were prosecuted for refusing to sell to the inspector, and the corporation was prosecuted for selling adulterated drugs to the Riker-Jaynes Company. Parke, Davis & Co. did not care to substantiate their guarantee to the Riker-Jaynes Company, but relied upon a technical defence by showing that the tablets might have come from a shipment from the New York house as well as from the Boston house. They were discharged upon this case, but were convicted and fined $300 in the other case, and the two clerks were fined $50 each.

Summary of Articles confiscated by Inspectors.

Article.	Where confiscated.	Number of Confiscations.	Weight (Pounds).
Eggs,	Cold-storage warehouse,	133	25,115
Butter,	Cold-storage warehouse,	2	68
Poultry,	Cold-storage warehouse,	18	2,537
Meat,	Cold-storage warehouse,	30	8,814
Game,	Cold-storage warehouse,	4	866
Fish,	Cold-storage warehouse,	85	79,519
Totals,		272	116,919
Poultry,	Store, market or sausage factory,	1	13¼
Meat,	Store, market or sausage factory,	25	3,201¾
Fish,	Store, market or sausage factory,	2	3,295
Totals,		28	6,510
Poultry,	Slaughterhouse,	1	95
Meat,	Slaughterhouse,	24	5,186½
Totals,		25	5,281½
Grand total,		325	128,710½

EXAMINATIONS MADE IN THE LABORATORY.

The law requires that three-fifths of the appropriation for the enforcement of the food and drug laws shall be spent for the enforcement of the laws relating to the adulteration of milk and milk products. Under this provision the Division has collected and examined 7,958 samples of milk, 132 samples of cream, 14 samples of condensed milk, 9 samples of butter and 3 samples of cheese. In carrying out this work an attempt has been made to thoroughly cover the large cities and towns three or four times during the year, and to collect samples from nearly all the milk dealers at each visit. Special attention was given to those localities where experience has shown the liability of the presence of adulterated milk, and in addition the various vacation resorts have been visited during the height of the season. The traveling laboratory was extensively used in these summer resort investigations with good success.

The summary of milk statistics is given in Tables 3, 4, 5 and 6.[1] The average composition of the 7,796 samples collected by the inspectors and not declared adulterated was 12.66 per cent. total solids, 3.72 per cent. fat, and 8.94 per cent. solids not fat. The average fat which should correspond to these solids, according to the analyses of 1,000 samples of known purity milk collected and examined by this Department, should be 3.9 per cent. The average solids, corresponding to 8.9 per cent. solids not fat was 13.0 per cent. in the known purity samples. This condition of our commercial milk is brought about by the removal of cream in quantities too small for detection beyond a reasonable doubt. The figures obtained for the average milk not declared adulterated during the past eight years are as follows: —

YEAR.	Number of Samples.	Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).
1909, ...	4,242	12.78	4.10	8.68
1910, ...	5,032	12.85	4.02	8.83
1911, ...	4,341	12.83	4.00	8.83
1912, ...	4,516	12.66	3.89	8.77
1913, ...	6,154	12.69	3.84	8.85
1914, ...	5,502	12.70	3.82	9.88
1915, ...	6,765	12.68	3.82	8.86
1916, ...	7,458	12.66	3.72	8.94

These figures show a steady deterioration in the quality of milk sold in this State. If this was due to an increase in the number of Holstein cows there would be a reduction in the solids not fat, as well as in the solids and fat. The fat has been reduced by 0.28, while the solids not fat have increased by 0.26, a condition which is accounted for only by the removal of cream. This is further emphasized by the fact that the percentage of watered samples has decreased while the percentage of skimmed samples has increased. During 1914, 5.3 per cent. of the milk samples were watered; during 1915, 3.3 per cent. of the samples, and during 1916 only 2.0 per cent. were found watered. This reduction is significant in consideration of the facts that the same methods of analysis were employed during this period, and that suspicious localities were watched more closely in 1916 than during 1914. One and one-half per cent. of the milk samples taken in 1914 were skimmed, 1.0 per cent. in 1915 were skimmed, and 1.8 per cent. in 1916 were in a similar condition. In all probability milk dealers have ascertained that there is less probability of the detection of a small amount of skimming than a small amount of watering. Only the standard prevents a larger practice of this form of adulteration. Nine samples of milk contained sufficient visible dirt to be classed as adulterated, and cases were entered into the courts. The court in Blackstone found the defendants not guilty, notwithstanding the decision of the Supreme Court to the contrary; the court in Milford convicted but filed the cases, while the court in Newburyport convicted and imposed a penalty of $50 in each case. These dispositions of cases show the different viewpoints of the producing territory and the consuming territory regarding dirt in milk.

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[1] All tables referred to are in the Appendix.

One hundred and thirty-two samples of cream were examined, of which 5 were below the standard. A number of these samples were traced to one dealer, who was prosecuted. Inquiries are frequently made regarding the variation in the fat content of commercial cream, and partly for this reason, as well as to ascertain if there was any attempt made on the part of cream dealers to sell cream of lower fat content than it purported to be, the cream statistics for the past five years have been compiled and plotted after recomputing to a percentage basis in order to make the results comparable. The heavy cream of commerce is understood to contain 40 per cent. of fat, but the figures obtained show that in practice much of it falls below this figure. The plot showing the composite of all the figures indicates the preponderance of but two grades of cream, — heavy cream with a fat content of about 38 per cent., and light cream with a fat content of about 18 per cent.

The price of heavy cream as sold to the public is fairly uniform, while the quality is not uniform. The dealer buys cream upon its weight and its fat content and sells it by volume, regardless of its fat content except, however, that he furnishes the two grades, — heavy and light cream. The public should demand that cream be sold at retail upon its fat content, and should not be content with receiving cream containing 30 per cent. fat and paying for cream containing 40 per cent. fat. The Massachusetts standard requires cream to contain not less than 15 per cent. fat. This standard is lower than it should be, as cream of this consistency will separate into two layers upon standing, the upper layer having about 18 per cent. of fat and the lower layer about 12 per cent. of fat. This accounts to some extent for the number of samples found between 12 and 15 per cent. of fat, because dealers are not so particular in mixing cream before bottling as they are in the case of milk. In fact, if the cream contains above 18 per cent. of fat there is little or no indication of further separation of fat, due to the increased consistency of the product.

Three hundred and twenty-six samples of ice cream were examined, of which 18 contained less than the 7 per cent. of milk fat required by the statutes. Most of these samples which were sufficiently below the standard to require attention were traced to a single manufacturer, who was prosecuted and convicted. The variation in the fat content of the ice-cream samples collected and examined during the past four years has been computed in a manner similar to that of the cream samples. Ice cream is a manufactured article, the composition of which can be strictly controlled. When the ice-cream law was first put into operation the bulk of the ice cream sold contained about 13 per cent. fat. As the operation of the law continued the ice cream of commerce became somewhat inferior in quality, and in 1915 the bulk of it contained but 10 per cent. of fat. This was due, no doubt, to the commercial practice on the part of the wholesale dealers of selling upon the fat content. The figures for 1916 indicate that discrimination on the part of the public has forced the retailer to purchase ice cream of a higher fat content, and naturally pay a higher price for the article. It is a significant fact that the retail price of ice cream is to a large measure independent of its fat content.

Nine samples of butter were examined, of which 3 were rancid. Three samples of cheese and 13 samples of condensed milk were examined, all of which were of good quality. Two milk shakes were obtained in Boston drug stores, both samples being made from skimmed milk. In all probability this form of deceit is not uncommon, and apparently is permissible under our laws.

The summary of milk statistics will be found in Tables 1, 2, 3 and 4. The summary of the statistics of milk products will be found in Table 5.

Two thousand three hundred and thirty samples of food exclusive of milk were examined, of which 520 were adulterated. Nearly 500 of these samples were obtained from cold-storage warehouses, the balance being purchased from various stores throughout the State. The summary of the analyses of these samples will be found in Table 5.

Eighteen samples of bread were obtained and were subjected to fairly complete analysis. Of these samples 11 were white bread, 4 were graham bread, 2 were gluten bread and 1 was bran bread. All the samples were true to name; none were adulterated, and the variation in composition of the different loaves was found to be but slight, except in the case of gluten bread. The averages of the analyses of the white and graham bread samples, and the analyses of the 3 samples of gluten and bran bread are given in the following table. The high protein content of the gluten bread is notable.

CHARACTER.	Number of Samples.	Moisture (Per Cent.).	Ash (Per Cent.).	Proteins (Per Cent.).	Fat (Per Cent.).	Fiber (Per Cent.).	Sugar (Per Cent.).	Other Carbohydrates (Per Cent.).
White, . . .	11	32.77	1.27	8.31	1.37	0.25	6.38	50.39
Graham, . .	4	34.12	1.48	8.10	1.80	0.71	4.11	49.71
Gluten, . . .	1	32.55	2.05	16.00	0.38	0.31	4.45	44.26
Gluten, . . .	1	38.25	1.65	27.40	0.92	0.28	8.12	23.38
Bran, . . .	1	38.95	2.26	8.40	0.67	1.24	9.07	39.41

Five samples of sweet cider contained benzoic acid and 2 contained salicylic acid, without the necessary label; 3 contained preservatives and were labeled; and 12 contained no preservatives. Two samples of condimental sauces were preserved and not so labeled; 2 samples of preserved fruit and 29 samples of Hamburg steak contained sulphites, and that fact was not stated upon the labels.

One sample of cocoa contained sugar and arrowroot; 1 sample of lard was compound lard; 36 samples of maple products contained cane sugar; and 4 samples of olive oil were mixed with cottonseed oil.

Forty-one samples of scallops and 8 samples of oysters were found to contain added water. A number of prosecutions have been made against Massachusetts scallop fishermen, and the practice of soaking scallops has ceased by these people in this State. Scallops from Maine and from the south, however, are still being imported containing added water. The United States Department of Agriculture seems to be unable to stop this practice. The Massachusetts wholesale dealers have been aware of the fact that all cases of watered scallops found by this Department have been traced to their source, which in those instances where the goods came from other States must necessarily be referred to the United States Department of Agriculture. The dealers have taken advantage of this knowledge by purchasing and selling scallops which by reason of their practical experience they know to be watered.

Five hundred and twenty-seven samples of sausages were examined, of which 86, or 16 per cent., contained starch in excess of 2 per cent. Of those collected in December, January and February, 20 per cent. were adulterated; of those collected in March, April and May, 10 per cent. were adulterated; of those collected in June, July and August, 9 per cent. were adulterated; and of those collected in September, October and November, 19 per cent. were adulterated. The starch content of the average adulterated sample was 3.93 per cent., thus permitting the addition of 16 per cent. more water than the sausage meat itself would absorb. Twenty-eight of these samples contained between 2 and 3 per cent. of starch; 29 contained between 3 and 4 per cent.; 15 contained between 4 and 5 per cent.; 8 contained between 5 and 6 per cent.; 3 contained between 6 and 7 per cent.; and 1 each contained 7 per cent., 10.4 per cent., and 21.5 per cent. of starch, respectively. The sausage makers said that the price of beef was so high and competition so great that they could not sell at a profit unless they exceeded the 2 per cent. limit permitted by statute. It is significant that at the same time a number of meat dealers asked extensions of the time of storage of a large amount of beef, because beef was so low in price that the storage beef could not be sold without a loss.

A very large number of samples of food were found to be decomposed, the majority of which was obtained from cold storage, and all of which was intended for food purposes. The character and number of these samples are as follows: 209 samples of eggs (mostly broken-out eggs obtained from cold-storage warehouses or bakehouses); 17 samples of beef, 11 of which were in cold storage; 15 samples of pork in storage; 11 samples of nuts; 3 samples of rancid butter; 3 samples of fish in cold storage; 2 samples of shrimp; 2 samples of confectionery; 1 sample of sausage meat; and 1 sample of tomato pulp, making a total of 264 samples. In addition to this list a barrel of tuberculous lungs intended for manufacture into blood pudding was found in a sausage factory. These conditions should not exist; food is too costly to be permitted to undergo decomposition, and with proper refrigeration and care it will not happen. In the case of the eggs mentioned above, the decomposition was, to a large extent, fraudulent. The egg-breaking establishments were adding broken-out rotten eggs to good eggs in quantities sufficient in their estimation to "get by," and either miscalculated the quantities added or the eggs were in a worse condition than they anticipated. These eggs were placed in cans holding about 35 pounds each, transferred to cold-storage warehouses and frozen. Early in December four inspectors were detailed to visit the warehouses and obtain one sample from each lot of frozen eggs placed in storage in the Boston warehouses, and to visit the bakehouses and obtain samples of the broken-out eggs used in the preparation of food. Three days after this the egg breakers, becoming aware of the activities of the inspectors, began to withdraw the eggs from the warehouses, and they were immediately notified that the eggs were held under seizure by the Department. As soon as a lot had been examined and found not to be decomposed the owner and the warehouse were given formal notice of its release by the State Department of Health. As the inspectors began to reach those lots stored early in the season, the eggs were found to improve in quality, and therefore most of these lots were passed, or samples were taken, upon the result of a physical examination by the inspectors. All the lots found bad were seized by this Department and held in storage in the name of the State Department of Health until the cases resulting from the examinations were disposed of, and then the eggs were disposed of for purposes other than for food.

The prosecutions were brought against the egg breakers, but the bakers were asked to attend hearings. At these hearings they stated that the broken-out eggs were purchased at prices lower than they could break out and store them. The bakers were informed that if subsequent samples obtained from them were found bad no attempt would be made to trace the samples to the egg breakers, but that the bakers themselves would be held responsible. Subsequent samples obtained from these bakers were found to be satisfactory, and the resulting improvement in the quality of pies and pastry sold in Massachusetts is noticeable. Examinations were made of eggs in warehouses located elsewhere than in Boston, showing that the eggs so stored were in good condition.

For showing the presence of decomposed food in the samples submitted, the usual methods mentioned in former reports have been employed this year. They are in substance the determination of ammonia for the estimation of the extent of protein decomposition, the determination of fatty acids for the estimation of the rancidity of fats, and in egg whites the determination of sugar. In examining broken-out eggs all the figures must be compared with the fat, as the ammonia and acidity develop early in the yolks, which contain all the fat, and the loss of sugar occurs only in the whites. For the determination of sugar Klein's[1] modification of Bennedict's method for dextrose in blood was used. An attempt was made to apply to eggs the methylene blue reductase test for old milk, with only partial success. Old milk high in bacteria will decolorize methylene blue solutions in a short time, while fresh milk will not reduce these solutions in several hours. It was found that decomposed egg would decolorize methylene blue solutions at room temperature with great rapidity; in fact, such eggs were found to be about twenty-five times as active as old milk. Fresh eggs, on the contrary, were found to have but little decolorizing action upon the solutions. Owing to the difficulty of mixing the solution with the eggs, the time of decolorization was not so proportional to the extent of the decomposition as were the other quantitative figures obtained.

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[1] Personal communication from Mr. David Klein, State Dairy and Food Commission, Chicago, Ill.

In the spring of the present year a case of near-by eggs was purchased, candled and separated into three portions of 10 dozen each. One portion was placed in storage in the shell, another portion was placed in a cool place in waterglass, and the third portion was broken out, thoroughly mixed, placed in half-pint cans and placed in cold storage. These eggs were examined when first broken out, and from time to time samples are removed and examined chemically and bacteriologically. The results obtained will not be reported until all the eggs are examined. During the year 1914, 3 chickens and 3 ducks were placed in storage by this Department, and from time to time portions of the birds have been removed and examined. At present, after two and one-half years, no change has been observed in the proteins.

The methods employed are not always sufficient to establish the extent of protein decomposition. In a few instances fish has been obtained with normal ammonia-nitrogen ratio, yet undoubtedly decomposed, as judged by the senses. More research work must be carried out before we have the means of measuring the extent of all varieties of decomposition in food.

Eight hundred and seventy-four samples of drugs were examined, of which 177 were adulterated or below standard. Most of these varied slightly from the U. S. P. requirements. In those cases where the variation was excessive prosecutions were instituted. For the first time in many years adulterated olive oil was obtained from a drug store. A case has been entered in court relative to these samples which is still pending. Two samples of proprietary drugs were found to be in violation of the law, and were advertised by this Department as unsalable at retail. As they were put out by a Polander and would be dispensed through Polish stores, one of the advertisements was sent to a Polish newspaper requesting that it be translated and printed. Before the paper was printed a representative of the manufacturer called and requested that the advertisement be recalled from the

Polish paper, as its printing would have a deleterious effect upon the sale among the Polish people of all the remedies put out by him. The advertisement was not recalled, and by some misunderstanding with the paper was printed in heavy, conspicuous type. The summary of the drug statistics will be found in Table 6.

Fifty-one samples of liquor were submitted by the police authorities of 22 cities and towns. Of these samples 46 contained more than 1 per cent. of alcohol and 5 contained less than 1 per cent. of alcohol. The summary of these analyses will be found in Table 7. In Table 8 is given the summary of statistics of samples of poison submitted by police and other authorities. Of these samples 38 were legal, that is, contained no poison, and 162 contained poison.

The total number for this year is about 53 per cent. of those in 1915. The reason for this decrease is largely because the Watch and Ward Society submitted but one sample this year as compared with 150 samples the year before. One hundred and eighty of the samples were brought in by the Boston police, 5 from the Suffolk County jail, 2 each from the metropolitan park police, Middlesex County jail and Worcester police, and 1 each from the police of Adams, Groton, Haverhill, Somerville, Taunton, Wakefield, Waltham and State Police. Fifty-eight of these samples contained cocaine hydrochloride, 85 consisted of morphine or its salts, 9 contained heroin, and 4 were derivatives of morphine in quantities too small to be absolutely identified. A considerable number of alleged poisons and miscellaneous samples were found to be free from habit-forming drugs or other poisons, but 5 of these proved to contain injurious materials. Among them was a sample of coffee from the East Cambridge jail. It was brought to a prisoner by his wife, and owing to its queer taste aroused suspicion. Examination of the coffee showed morphine present. From Somerville a liquid was sent which was a 27 per cent. solution of formaldehyde. It was alleged that a woman gave this to her husband with intent to kill him, but on further investigation the police found 3 large bottles of the poison where the man was employed, and concluded that he drank the solution himself to cause the arrest of his wife.

The police of Groton sent in a piece of meat on which was some Paris green. No court proceedings resulted in this case. A quart of milk containing nearly 1 per cent. of Paris green was submitted by the Worcester police. Inquiry as to the outcome showed that they were unable to maintain a case, as it appeared that the complainant herself put the poison in the milk. The Wakefield police submitted a soup plate and strainer on which were patches of Paris green. An

Italian woman was suspected of poisoning her husband. His account of the affair was that he ate the soup which she prepared and then noticed the green substance on the bottom of the dish. He rushed to the druggist and was given an emetic. The police were notified. They testified that they went to the house and found the woman alone and also the dish and strainer in which was the green material. The woman was arrested and tried. The court maintained that a guilty person, having ample opportunity, could have destroyed all evidence by washing the dishes carefully, and, as the defendant did not do this, she was not found guilty.

The general summary of samples examined is as follows: —

General Summary of Analyses.

	Legal.	Illegal.	Totals.
Milk,	6,183	1,775	7,958
Foods, exclusive of milk,	1,810	520	2,330
Drugs,	697	177	874
Totals,	8,690	2,472	11,162
Poisons,	38	162	200
Liquors,	5	46	51
Linseed oil and turpentine,	2	–	2
Totals,	8,735	2,680	11,415

COLD STORAGE.

The Massachusetts cold-storage law went into effect Sept. 1, 1912, and has therefore been in operation for four years. The law describes cold storage to mean the storage of food at or below a temperature of 40° F. in cold-storage warehouses; it describes cold-storage warehouses as places artificially cooled to 40° F., or below, where food is stored for thirty days or more; and it describes food as including fresh meat, fresh meat products (except in process of manufacture), fresh food fish, poultry, eggs and butter. Warehouses must obtain a license from the State Department of Health, paying $10 per annum. The license must be issued if the place is in a sanitary condition. Each licensee must render every three months, beginning on January 1, a quarterly report, stating the amount of food placed in storage during the quarter, and the amount of butter and eggs on hand upon the first day of January, April, July and October.

No decomposed food must be placed in storage; no food can be held in storage for more than one year, except with the consent of the State Department of Health; no article removed from storage for sale can be returned to storage; and all articles of food, except fish, when placed in storage, must be marked with the date of entry.

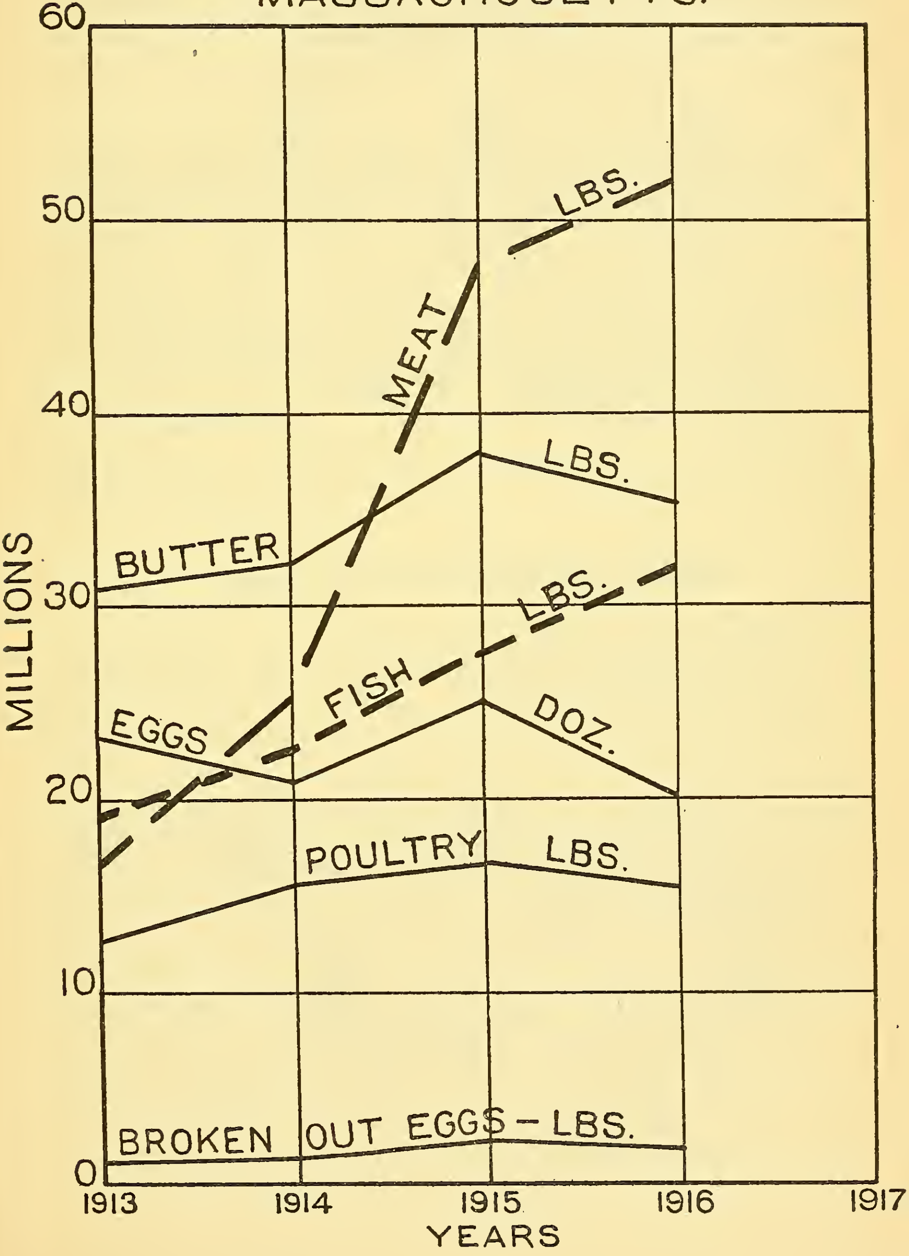
The law also provides that cold-storage food shall not be advertised as fresh food, and that the dealers selling such food must display a sign marked "Cold Storage Goods Sold Here." The cold-storage egg law provides in addition that the package delivered to the customer must be labeled "Cold Storage Eggs."

During the present year this Department has licensed 75 cold-storage warehouses, a list of which will be found in Table 11. These warehouses may be roughly divided into four classes, — public warehouses, private warehouses, fish freezers and meat freezers. The meat freezers, of which there are but 5 in this State, are used for the storage of meat from animals slaughtered in connection with the establishment. The fish freezers, of which there are 15, are in general privately owned warehouses, and are operated for the purpose of freezing fish as soon as caught. Considerable of this fish is shipped out of the State. One of the fish freezers in this State is a notable exception in that it is a public storage warehouse, and in addition to freezing fish freshly caught, freezes any fish which may be submitted by local dealers. The other public storage warehouses will accept, in general, any article submitted by any person, and will store it for one year upon payment of the usual storage charges.

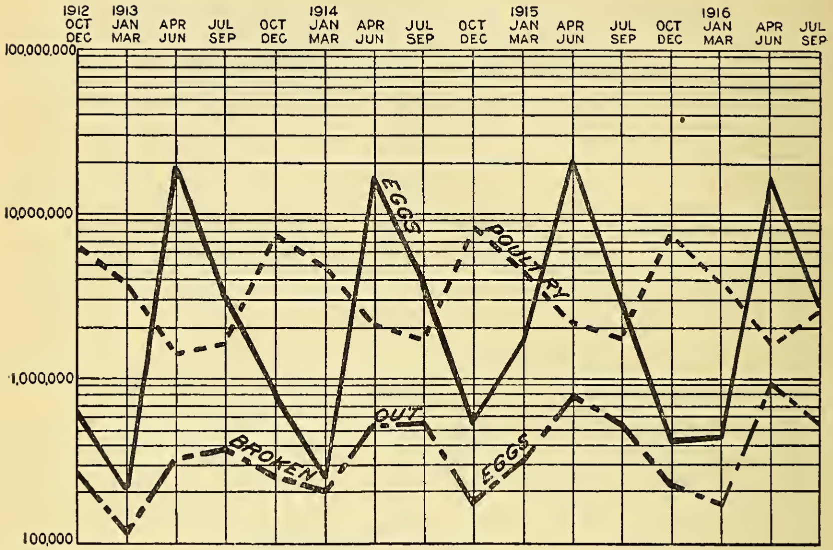
Upon receipt of an application to operate a cold-storage warehouse, one of the inspectors of the State Department of Health visits the plant and examines it for its sanitary condition, ascertaining whether or not the employees understand the law and will carry on the business in a legal manner, and if the result of this inspection is satisfactory the license is granted.

The law prohibits the storage of food for a period of more than twelve months without the consent of this Department. The owners of goods in storage, who for any reason desire to hold the articles for a longer period, request this Department to grant an extension, stating the reasons for such request. Upon receipt of this request, one of the inspectors visits the warehouse and makes a thorough inspection of the goods to ascertain if they are in proper condition for further storage. If the inspector's report is favorable, and if the request for extension is reasonable, the extension is granted. If the inspector is of the opinion that the articles are not in proper condition for further storage the request is refused. Occasionally, before refusing or granting requests a sample of the article is obtained and

AMOUNT OF FOOD
PLACED IN COLD STORAGE.
MASSACHUSETTS.



ARTICLES PLACED IN COLD STORAGE



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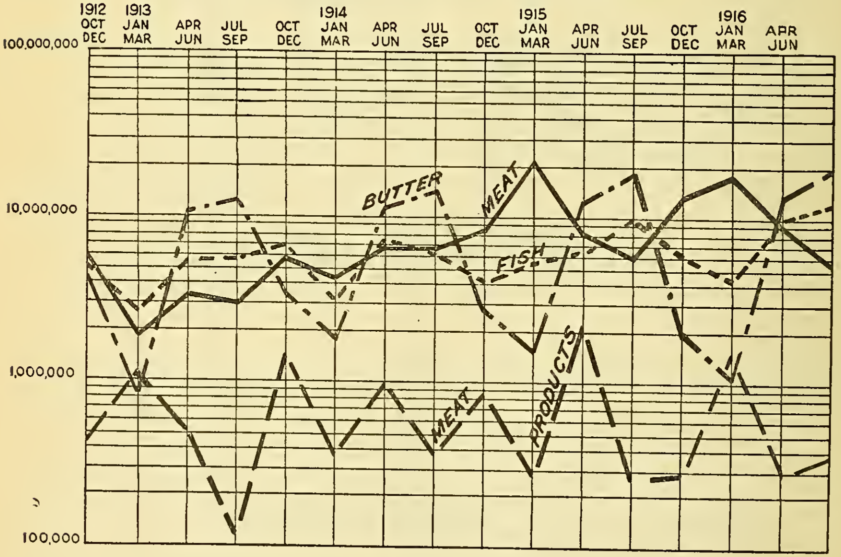


subjected to chemical analysis. This is particularly true of butter, which may be developing a rancidity which is not apparent to the inspector, but which will increase with further storage. If the extension is granted, the owner of the goods and the warehouse is notified, and a record is kept in the office of the Division of the time when the extension expires. Shortly after this expiration the inspector visits the warehouse and ascertains whether the goods have been removed.

The warehouses are obliged to submit a quarterly report of the amount of articles placed in storage, and from these reports the figures used in compiling the three charts have been obtained. A study of the chart showing the total amount of food placed in storage indicates a large increase in the storage of meat and fish, a slight increase in the storage of butter, a much smaller increase in the storage of poultry, and a decrease in the storage of eggs. The charts showing the quarterly storage indicate a variation in storage by seasons. The egg storage is greatest and the poultry storage is least in the spring. The poultry storage is greatest in the fall and winter, when the egg storage is very slight. The storage of butter follows the same general tendency as that of eggs, except that the variation is much less, and the summer storage is greater than the spring storage. Meat and fish appear, according to the charts, to be stored fairly uniformly throughout the entire year. If these figures were reported monthly they would have a different significance. Practically no fish, eggs or butter are stored in December, January and February, except such that may have been transferred in the frozen condition from one warehouse to another. A change in the law is desirable requiring that monthly reports be made, thereby making the statistics of more practical value, and obtaining information for use by the Department at more frequent intervals. It will be noticed that there was a large storage of meat during the three months January, February and March, 1915. This, in all probability, was due to the prevalence of the hoof and mouth disease, as many farmers sacrificed their herds for beef rather than run the risk of an infection and subsequent total loss of the herd. The summary of the quarterly reports for the year ending Sept. 30, 1916, are given in the following table: —

Articles placed in Cold Storage and Quantities of Butter and Eggs held in Cold Storage during the Year Oct. 1, 1915, to Oct. 1, 1916.

Articles placed in Cold Storage.

	October, November, December, 1915.	January, February, March, 1916.	April, May, June, 1916.	July, August, September, 1916.	Totals.
Eggs, case (dozens),	397,590	420,360	17,220,756	2,853,660	20,892,366
Eggs, broken out (pounds),	221,177	162,054	938,369	523,190	1,844,790
Butter (pounds),	1,950,467	1,153,681½	13,004,674	19,679,114	35,787,936½
Poultry (pounds),	7,478,331	3,909,261	1,774,667	2,296,832	15,459,091
Game (pounds),[1]	379,441	13,050	2,808½	2,644	397,943½
Meat, fresh, and Meat Products, fresh (pounds).	15,784,450	20,198,672½	9,860,082¼	5,992,913	51,836,117¾
Fish, fresh food (pounds),	6,475,836	4,394,967	10,053,298	10,918,164	31,842,265
Totals,[2]	32,687,292	30,252,046	52,854,654¾	42,266,517	158,060,509¾

Butter and Eggs held in Cold Storage.

	Jan. 1, 1916.	Apr. 1, 1916.	July 1, 1916.	Oct. 1, 1916.
Eggs, case (dozens),	16,288,146	61,978	6,179,490	12,418,560
Eggs, broken out (pounds),	70,646	126,780	135,858	63,524
Butter (pounds),	11,954,812	1,054,273	14,041,163	23,462,826
Totals,[2]	28,313,604	1,243,031	20,356,511	35,944,910

[1] In addition to the game listed, 589 packages were reported on which no weight was given.

[2] Inasmuch as the contents of 1 dozen eggs averages 1 pound, the dozens of eggs are added with the articles reported as pounds.

There are, undoubtedly, many errors in the figures reported by the warehouses. The nature of the figures is such that with the exception of those relating to butter and eggs it is impracticable to check their accuracy. The warehouses are required to report the amount of butter and eggs on hand at the beginning of each quarter. It has been found in many instances that warehouses have reported more eggs on hand at the end of the given quarter than the combined amount of the eggs placed in storage during the quarter and the amount on hand at the beginning of the quarter. This is due to faulty methods in keeping the warehouse accounts, over which, of course, this Department has no control. These figures also include many transfers. A great number of eggs are taken from the public warehouses and transferred to the private warehouses, thereby, according to the returns, showing an apparent increase in the numbers of eggs placed in storage. In a similar manner transfers of fish are made from the fish freezers to public warehouses or private warehouses and again recorded as articles placed in storage. Another source of inaccuracy in the figures was recently discovered when the warehouses were requested to state the character of articles they reported as meat products. It was found that some warehouses failed to report storage of meat to be subsequently used in the manufacture of sausages, and that many warehouses reported meat under the name of meat products.

The number of requests granted for extension of the time of storage is somewhat less than granted during the past two years. During 1914 there were granted 138 such requests, during 1915 there were granted 218 such requests, and during 1916 there were granted 127 such requests. The number of requests for extension of time in storage refused during these three years was 8, 7 and 23, respectively. Of the requests refused during the present year, 15 were not in proper condition for further storage, 3 had been overlooked by both the owners and warehouses, having been in storage fifteen months before the request for extension was made, 2 were requests for extension beyond the time already granted, and 3 had been previously stored in other States. Thirty-four lots were ordered removed from storage upon the expiration of the year, after examination by the inspectors. The list of extensions will be found in Table 9, Appendix.

The number of confiscations of food in cold storage was much greater than in previous years. During 1914 there were 52,659½ pounds of food confiscated, during 1915 there were 71,734 pounds confiscated, and during 1916 there were 125,400½ pounds confiscated. It is unfortunate and unnecessary that food be permitted to become rotten before the owners place it in cold storage. This food should have been properly preserved before decomposition had set in, and the food itself as well as the labor expended upon it would not have been wasted.

INSPECTION OF SLAUGHTERING.

The statutes require that local boards of health must annually in March nominate one or more inspectors of slaughtering. These nominees cannot be appointed inspectors of slaughtering until they have been approved by the State Department of Health. In general, these nominees are approved, but occasionally the Department finds it necessary to make disapprovals. Nominees are disapproved for the following reasons: —

1. Members of local boards of health are disapproved, according to

advice from three Attorneys-General, that it is illegal for persons to appoint themselves to office.

2. Persons engaged in the business of slaughtering are disapproved because it is not expected that any person can give an unbiased opinion of his own work. If a man is in the business of slaughtering and is the inspector, he would be liable to lose business if he made it a practice of condemning carcasses which he himself had slaughtered. The temptation to pass meat which should be condemned is, therefore, greater if the inspector is the slaughterer than if he were not the slaughterer.

3. Persons convicted for violation of the slaughtering laws are invariably disapproved. The reason is obvious.

4. Persons who, in our opinion, have violated the slaughtering laws, and against whom insufficient evidence can be secured to warrant conviction in court, are, as a rule, disapproved if the evidence is in our opinion sufficiently circumstantial to warrant the action.

5. Incompetent persons are disapproved.

It is a difficult matter to pass upon about 400 nominees for these various positions throughout the State between the time the nominations are received and the first day of April. It was formerly the practice to send inspectors about the State to see the various nominees and to report upon their qualifications. This was a very expensive mode of procedure, and in some respects was unsatisfactory owing to the difficulty of finding the man at home, in many instances, at the time when the inspector called. A slightly different mode of procedure was put into operation this year, with very good results. This procedure is as follows: —

1. A circular letter is sent to each board of health on the 1st of March calling their attention to the necessity of making nominations for the position of inspectors of slaughtering, and inclosing a blank upon which the nominations are to be made.

2. Upon receipt of the nominations a blank is sent to each nominee asking (*a*) the name, address and occupation of the nominee; (*b*) whether or not the nominee is engaged or intends to be engaged in the business of slaughtering; (*c*) whether or not the nominee is a member of the local board of health; (*d*) the names and addresses of three persons who know his qualifications; (*e*) whether or not the nominee is familiar with the laws and regulations relative to slaughtering; (*f*) the qualifications of the nominee for the position.

3. When the blank is returned the references are written to. Each reference is asked to give (*a*) his name, address and occupation; (*b*) to state whether or not he is a member of the local board of health; (*c*) to state whether or not the nominee is in the business of slaughtering

or intends to slaughter; (*d*) to state whether or not the nominee is qualified for the position, and (*e*) to state the nominee's experience for the position.

4. The office records relating to the nominee are consulted, provided that the nominee had formerly held the position of inspector of slaughtering.

5. If necessary, an inspector of the State Department of Health visits the nominee or other persons and obtains additional information.

6. If necessary, the District Health Officer is consulted relative to the advisability of approving the nomination.

7. The inspector is either approved or disapproved.

The only serious objection to this mode of procedure is that the nominee furnishes his own references, but in several instances these references have given evidence upon which, after investigation, the nominee has been disapproved. This year we have carried out the system as nearly as possible in its entirety. In the future it will not be necessary to go so completely into details in the case of persons who are renominated.

This procedure has saved the State considerable money, and at the same time it is believed that the work was accomplished in a better and more satisfactory manner than under the methods formerly applied.

From 345 cities and towns 526 nominations have been received, considered and disposed of as follows: —

Nominations for the Office of Inspector of Slaughtering, March 31, 1916, to Dec. 1, 1916.

Number of nominations made by local boards of health,		526
Number of nominees approved by the State Department of Health,	473	
Number of nominees disapproved by the State Department of Health,	43	
Number of nominees upon which the State Department of Health took no action,	10	
Nominations made late in the year, still pending,		18
Cities and towns making no nominations,		8

Of the total number of nominations made, 87 were new nominees.
Of the nominees approved, 18 resigned and 3 died.
Of the nominees disapproved, 9 were reconsidered and approved.

Four hundred and ninety-six copies of licenses to slaughter, granted by local boards of health and selectmen, were sent to this Department.

These inspectors are required to make a quarterly report upon the number of carcasses inspected, confiscated and the causes thereof. The report for the year ended September 30 is given in Table 13. There has been a material increase in the number of carcasses inspected compared with the inspections of 1915, due in part to the repeated demands made by this Department to the inspectors that they file their reports, and also to the fact that the boards themselves were informed of the laxity of their inspectors. The increase in carcasses inspected was 71,685, or 57 per cent. The increase in the case of cattle was 28 per cent.; in the case of calves, 34 per cent.; and in the case of hogs, 135 per cent. There was an increase in the percentage of total confiscations and in confiscation of calves, a decrease in the percentage confiscations of hogs, and no change in the percentage confiscations of cattle. The figures for 1915 and 1916 are as follows: —

	Year.	Inspected.	Confiscated.	Per Cent. confiscated.	One Confiscation of every —
Total,	1915,	125,283	1,585	1.27	78
	1916,	197,128	2,767	1.41	71
Cattle,	1915,	22,729	510	2.29	44
	1916,	28,547	653	2.29	44
Calves,	1915,	60,696	721	1.18	84
	1916,	80,853	1,593	1.97	51
Hogs,	1915,	34,355	348	1.02	98
	1916,	80,909	498	0.62	161
Sheep,	1915,	7,953	6	0.08	1,324
	1916,	6,819	23	0.34	296

The prevailing reason for confiscation in cattle was tuberculosis, which was responsible for 87 per cent. of the losses. Parturient apoplexy and disturbances of the sexual organs were responsible for nearly 4 per cent. of the confiscations. The prevailing cause for confiscation among the calves was immaturity; among the hogs, hog cholera, tuberculosis and pneumonia, representing 41 per cent., 28 per cent., and 13 per cent., respectively, of the loss. Confiscations of sheep are unusual, but in the present year a number of sheep were confiscated because of nodular disease, a parasitic intestinal infection. The summary of confiscations is shown in the following table. The details of inspections are given in Table 10.

The reports received from local inspectors stated that in 153 localities there were no confiscations. Seventy-four of these localities reported inspections in numbers too low to expect diseased conditions to be found, as judged by the total numbers reported; in 53 of these localities no confiscations were reported in 1915. The total carcasses inspected in these 74 localities was 338 cattle, 772 calves, 3,090 hogs and 513 sheep. According to the statistics, 8 cattle, 15 calves and 19 hogs were in all probability diseased. In 79 localities reporting no confiscations, sufficient numbers were inspected to expect at least one confiscation in each locality. In 45 of these places no confiscations were made in 1915. The total carcasses inspected in these places was 1,917 cattle, 4,852 calves, 12,863 hogs and 585 sheep. According to the statistics 44 cattle, 57 calves and 131 hogs were in all probability diseased. In only a few of these localities is the inspection of such a rigid character that the butchers are unusually particular as to the character of the animals purchased, so the percentage of confiscations would fall much lower than those computed from the inspections of the entire State.

Without doubt the laws relating to slaughtering are violated more than any other food laws of the State, with the possible exception of the milk laws. Our present system of local inspection is far from ideal. The small cities and towns of this State cannot afford to pay sufficient salaries to their inspectors, and undoubtedly, in many more instances than our veterinary inspectors have discovered, these men are very lax in their duties, and frequently stamp carcasses which they have not seen slaughtered and have not inspected, and also stamp many carcasses, the organs of which they have not examined. In order to save money some localities desire the local butcher to be the inspector. The law regarding inspectors of slaughtering states that the inspectors shall be paid reasonable salaries by the cities or towns appointing them. In a few instances it has been ascertained that a portion of the salaries of these men has been paid by the butcher.

Certain towns spend considerable money on their inspection, this money being entirely out of proportion to the needs of the town. One town in this State, near a large city, supports two slaughterhouses and two inspectors. Fully 80 per cent. of the animals killed at these slaughterhouses are purchased in Brighton, shipped to the slaughterhouse, and the carcasses are sold in the neighboring city. This town is a farming community, and the farmers demand of the selectmen that these two licenses be issued in order that the farmers may have some competition in selling the animals that they themselves desire to dispose of for food purposes. In this town the inspection is carried on in a very satisfactory manner, costing from $1,000 to $1,500 per annum.

In many localities, however, it appears that a lax system of inspection is desired in order that the farmers may sell their cattle, which, by reason of disease, are liable to die, or which have died, and which they hope the inspector will pass for food purposes, in order that the animal may not be an entire loss to the farmer. A study of the character of the confiscations shows undoubtedly that this is the case. Many instances of confiscations of cows because of parturient apoplexy indicate that it is a common thing for farmers to carry to the slaughterhouse cows which are dying on account of difficult parturition. In addition, there is more or less meat passed in the country slaughterhouses which is obtained from animals coming to their death other than by slaughter. One instance of this nature occurred in a slaughterhouse in another town near the large city referred to above. One of the veterinary inspectors of this department was in this slaughterhouse and saw the carcass of a cow all dressed and quartered, apparently ready for shipment. The carcass was not stamped. He examined the carcass carefully and called in the inspector, informing him that owing to the large amount of blood in the carcass the animal undoubtedly had died before being bled. The inspector replied that that cow had died in a neighboring town and was carted to the slaughterhouse in order to have the hide removed. This seems to be rather inconsistent, because the hide could very readily have been removed in the first town, and furthermore, it seems inconsistent that the carcass whose hide only was to be used should have been dressed as if for food purposes. This carcass was confiscated by our veterinary inspector and a receipt for the confiscated carcass was returned to this Department. A few weeks later evidence was obtained in the same town of another violation of a similar nature. A farmer went out to his barn one morning and found his cow strangling. He cut the cow's throat and carried the carcass to this slaughterhouse, where it was confiscated by the inspector because of tuberculosis. The inspector, however, did not cause the carcass to be destroyed, and it was shipped to a meat dealer in a nearby city and subsequently was sold by him for manufacturing into sausages. The farmer, when he discovered these facts, demanded pay for the carcass, and upon being refused, brought this matter to the attention of the city board of health. The veterinary inspector of this Department, in collaboration with the inspector of the neighboring city, obtained sufficient evidence to prosecute the butcher, the inspector and the meat dealer for violation of the slaughtering laws. Without doubt, if the farmer had received his pay for the carcass, this information never would have been transmitted to the officers.

The veterinary inspectors of this Department have visited, during the latter half of the year, 117 cities and towns in which they have seen the local inspectors of slaughtering. The results of these visits show that 100 of these men were apparently satisfactory and that 22 were not doing satisfactory work. In 58 instances the original records which the inspector made relative to his inspections were examined and found to be in satisfactory condition; in 35 instances these records were unsatisfactory; and in 6 instances the inspector had no record whatsoever of his inspections. Twenty-three of the inspectors were unable to show their records to our veterinary inspectors at the time of their visits. Of the records which were unsatisfactory, most of them failed to note the number of confiscations made and the reasons for such confiscations. The quarterly reports submitted to this Department by these inspectors must have been made largely from memory when any confiscations were reported.

It is in some respects surprising that local boards of health will renominate men who have been convicted of violating the slaughtering laws. One such inspector who was permitting the sale of diseased meat for manufacturing into sausages was renominated by the local board of health immediately after the completion of the court case. He was, of course, disapproved. The board shortly afterwards made another nomination. This nominee was investigated by the District Health Officer, who gave an unsatisfactory report, and the nominee was disapproved. During the interim one of the veterinary inspectors happened to be in the neighborhood of this man, and ascertained that he knew nothing whatever of the post-mortem examination of carcasses. The board of health, after the disapproval, requested reconsideration, stating that the information received from the District Health Officer was not entirely from reliable sources. Upon receipt of this letter another veterinary inspector was sent to investigate the qualifications of this man, and reported that he was entirely unsuited for the position, and in addition knew nothing of the character of the work he was supposed to perform. The board of health of that town was fully aware of the many attempts made by the butcher to violate the law, and also was aware of the fact that their inspector had permitted such violations.

One industry not now under supervision, which should be strictly supervised, is the boning of meat. In the local slaughterhouses in Massachusetts there is considerable trade in boned meat which is sold to sausage factories. This work is of such nature that there is every opportunity to violate the law, over which control is difficult if not impossible under the present laws. If the local inspector does not cause a confiscated carcass to be removed from the slaughterhouse and rendered, or does not spray it with kerosene, in all probability this carcass will find its way into the boned meat. Under the present conditions slaughtering can be carried on in the absence of the inspector, and the slaughtered carcass can be boned and placed in barrels. There is practically no way of telling from the appearance of this boned meat whether or not it has been inspected. The law requires that all packages containing meat shall be stamped or branded by the inspector, and shall bear a tag containing the words "Massachusetts, Inspected, Passed." This tag may be attached by the licensee. This gives absolutely no protection to the consumer, as there is no way of ascertaining whether or not the shipper has complied with the law and placed only inspected meats in the package. An example of a violation of this sort was found recently in the city of Brockton. One of the veterinary inspectors of this Department found in a Boston sausage factory a barrel containing lungs, some of which were tuberculous. These were to be used in the manufacture of sausages, and were shipped by a Brockton butcher to the Boston sausage maker. In this instance the tuberculous lungs had been taken from the refuse pile where they had been thrown by the Brockton inspector. These establishments for the boning of meat should be licensed, preferably by the State, in order to limit their number, and boning should be permitted only in the presence of an inspector appointed by the State, who would thus be able to ascertain the character of the carcasses used in the preparation of meat for manufacture into sausages.

The Legislature of 1916 passed an act permitting farmers to slaughter animals for their own use without inspection. It is a practice among some inspectors, when they have seen the animals alive, to notify the owner that in all probability they may not pass the carcass if the animal gives any indications of not being in a satisfactory condition. The inspector of Agawam in this manner notified a farmer that he would not pass a certain boar which the farmer had brought to the slaughterhouse. The farmer then took the boar home and sold him alive to an Italian. The Italian killed the animal without inspection, took the meat home for his own consumption, and presented a considerable quantity of it to his neighbors and friends. This action resulted in 10 cases of trichinosis, the detailed accounts of which will be found in the report of the Division of Communicable Diseases.

Dairy Inspection.

The law relating to the issue of milk permits by local boards of health was amended last year in such a manner that, in addition to inspecting the dairy, the local board of health must inspect the places where the milk is handled and also must make an inspection of the milk. Eleven boards of health have informed this Department that they have revoked 9 milk permits, refused 1 milk permit, excluded the milk from 16 dairies, and removed the restrictions previously placed in 9 instances. Of the total dairies from which the milk was excluded Brookline reported 8, Somerville reported 7, Attleboro and Worcester reported 2, and Amesbury, Cambridge, Fitchburg, Lowell, Northampton, Saugus and Springfield reported 1 each.

Forty-nine dairies were inspected by this Division during the past year, the majority of which was done at the request of local boards of health. In some instances our inspector acted as an instructor to the local inspector; in other instances our services were desired to check up the work of the local inspector, as local dairymen had complained of the strictness of the local inspector. In all these latter instances, however, our own inspector's scores were substantially the same as those of the local inspector. A few dairies were inspected in connection with cases pending in court relative to the sale of dirty milk. The following is a summary of these scores: —

The United States Score Card allows a total of 6 points for cleanliness of stable. One stable scored 0; 7 scored between 1 and 2, average 1.2; 12 scored between 2 and 3, average 2.2; 24 scored between 3 and 4, average 3.2; 4 scored between 4 and 5, average 4.1; and one dairy scored 5.3. The score card allows a total of 5 points for milk houses. Of these 49 dairies, 20 scored 0; 12 scored from 1 to 2, average 1.1; 10 scored from 2 to 3, average 2.3; 3 scored between 4 and 5, average 4.4; and 1 scored 5. The score card allows a total of 40 points for equipment. Of these dairies, 1 scored 6.7; 21 scored between 8 and 16, average 12.9; 21 scored between 16 and 24, average 18.4; 5 scored between 24 and 32, average 27.3; and one dairy scored 35.1. The score card allows a total of 60 points for methods. Three dairies scored between 12.24, average 18.9; 36 scored between 24 and 36, average 31.2; 8 scored between 36 and 48, average 38.9; and 2 dairies scored 52.3 and 52.5, respectively. The general average for methods is notably higher than that for equipment.

Of the total scores 7 were between 20 and 40, with an average score of 33.6. Scores of this nature represent very poor conditions. Thirty-five scored between 40 and 60, average 48.1; 6 scored between 60 and

80, average 67.5; and one scored 87.6. These dairies were nearly all Massachusetts dairies, a few being located in Thompson, Conn., supplying milk to the town of Webster.

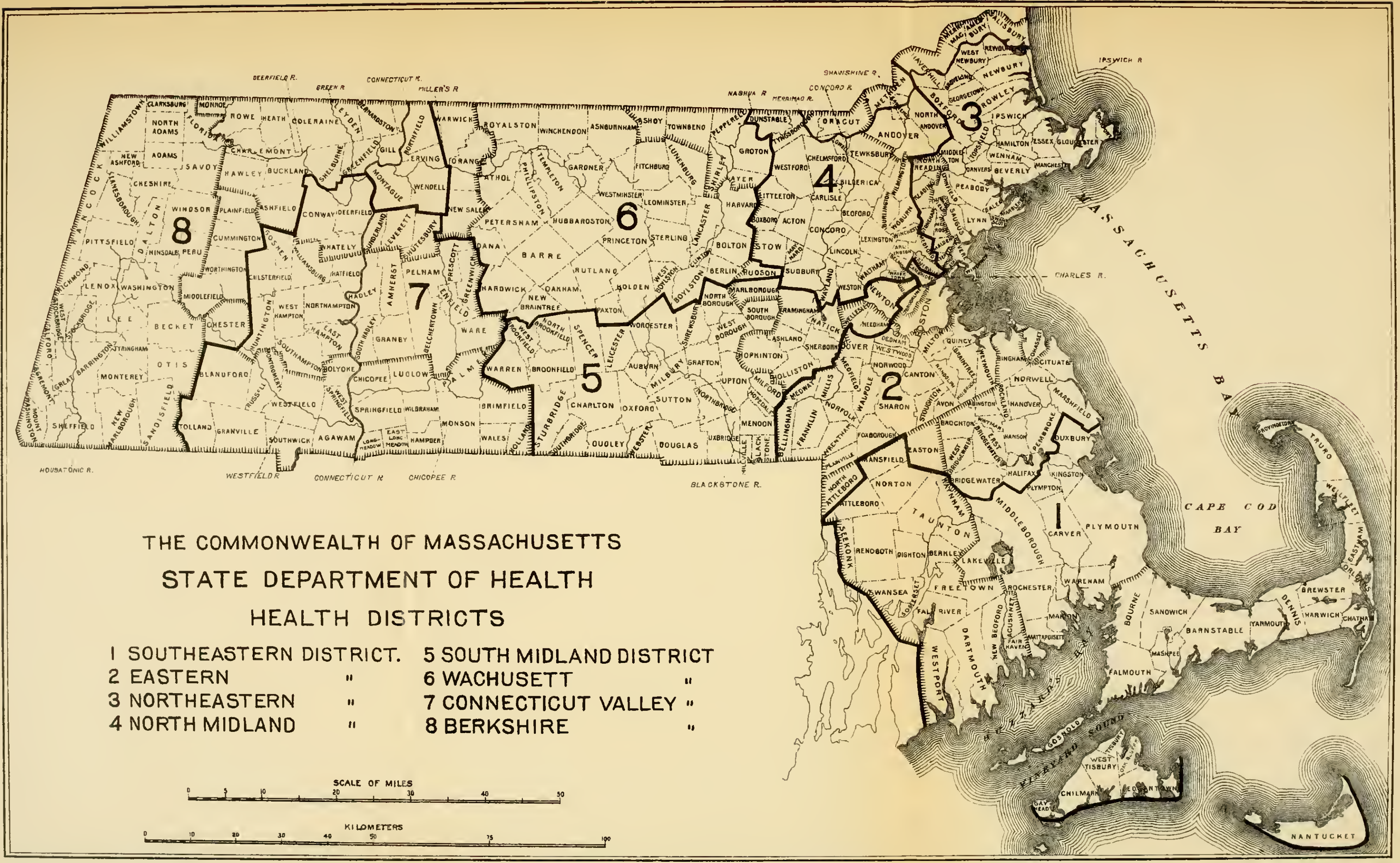
Manufacture of a Remedy to prevent the Transmission of Syphilis.

The Legislature passed a resolve appropriating $10,000 for the purpose of making investigations relative to the preparation and distribution of a remedy to prevent the spread of syphilis. The work of preparing this remedy has been carried out in the Food and Drug Division with considerable difficulty, partly owing to the crowded laboratory conditions, and partly owing to the difficulty in securing the raw materials necessary. The work was begun rather late in the year, owing to the uncertainty as to how and where the experimental work was to be carried on. It was finally deemed advisable to carry out the entire research work under control and supervision of employees of the Food and Drug Division, in addition to those actually carrying out the work.

This research has been successfully accomplished. Each step of the process can now be carried out by at least two of the regular employees of the Department. The technical difficulties involved have been very extensive, but have been entirely overcome. The substance obtained has been subjected to pharmacological examination, and has been found to be free from any properties which would act disastrously upon human beings to whom the remedy might be given; that is, it contains the required amount of arsenic in a non-toxic form.

DIVISION OF COMMUNICABLE DISEASES.

EUGENE R. KELLEY, M.D., *Director.*



THE COMMONWEALTH OF MASSACHUSETTS
STATE DEPARTMENT OF HEALTH
HEALTH DISTRICTS

1 SOUTHEASTERN DISTRICT.
2 EASTERN "
3 NORTHEASTERN "
4 NORTH MIDLAND "
5 SOUTH MIDLAND DISTRICT
6 WACHUSETT "
7 CONNECTICUT VALLEY "
8 BERKSHIRE "

HELIOTYPE CO. BOSTON

REPORT OF DIVISION OF COMMUNICABLE DISEASES.

I. ORGANIZATION AND CHANGES IN PERSONNEL.

There have been no changes in the organization of the Division during the fiscal year. The following important changes have been made in the personnel of the Division.

The State District Health Officer of the Berkshire District, Dr. Lyman Asa Jones, was transferred to the Northeastern District, replacing Dr. William Hall Coon, who resigned Nov. 30, 1915. The Berkshire District vacancy was filled on Feb. 1, 1916, by the appointment of Dr. Stanley H. Osborn from the eligible list.

Dr. Lewis Fish, State District Health Officer of the Wachusett District, resigned on July 1, 1916, to resume private practice, and Dr. Lyman Asa Jones was appointed director of the Division of Hygiene, the appointment taking effect on Sept. 1, 1916. The two vacancies made by the resignation of Dr. Fish and the transfer of Dr. Jones were filled by two appointees selected as the result of a competitive examination held on May 25 and 26, 1916. Dr. Francis A. Finnegan was appointed State District Health Officer of the Wachusett District, and Dr. Arthur A. Brown was appointed State District Health Officer of the Northeastern District, these appointments taking effect on July 1, 1916, and Aug. 1, 1916, respectively.

On Nov. 1, 1916, Dr. Walter H. Brown, epidemiologist to the Department, resigned to accept a position as city health officer in the city of Bridgeport, Conn. The vacancy caused by his resignation has not yet been filled.

The accompanying map indicates the territory assigned to each health district.

II. LEGISLATION PASSED DURING THE YEAR DIRECTLY AFFECTING THE WORK OF THE DIVISION.

1. The tuberculosis hospital law as it stood compelled cities and towns of 10,000 population or over to build and maintain hospitals for tuberculosis or other diseases dangerous to the public health when ordered so to do by the State Department of Health. This put no burden whatever on towns of less than 10,000 population in the local care of their people suffering from tuberculosis. The new law compels

counties to build tuberculosis hospitals for cities and towns of less than 50,000 population. Cities of over 50,000 population take care of their cases themselves as under the old law. They are exempted from taxation for the building and maintenance of county hospitals, as are also cities and towns of less than 50,000 population that are already maintaining and continue to maintain suitable hospitals for cases of tuberculosis. Four counties are exempted for specific reasons.

2. An act was passed giving boards of health power until Jan. 15, 1917, to quarantine contacts in poliomyelitis cases.

III. Diseases Dangerous to the Public Health.

As the returns of cases and deaths from communicable diseases are contrasted with past years, very striking and permanent gains in disease prevention must be set down to the credit of modern methods. Typhoid fever, diphtheria, ophthalmia neonatorum, scarlet fever, all show pronounced and encouraging decreases when the statistics in this Commonwealth are viewed for any considerable series of years.

Particularly encouraging is the fact that epidemics are being avoided to a much greater extent than formerly. The Commonwealth owes this extremely happy showing largely to the work of the State District Health Officers. They are constantly on call, situated in different parts of the State, and in close daily contact with the local boards of health. For this reason it is possible for the local boards of health to receive expert advice and assistance at the very beginning of the disease outbreak, — the time when most effective work in disease prevention can be done.

The system of disease reporting in this State is now such that it is practically impossible for any disease to become epidemic in any community without the fact becoming obvious at the very earliest stage of its development. This is brought about by a threefold check.

First. — The local boards of health scan carefully the returns day by day from the physicians. However, a local health department may do this and yet overlook for several days the beginning of an epidemic. This is well illustrated by the experience of New York City at the beginning of the great poliomyelitis epidemic of this year.

Second. — The local board of health reports daily both to the State District Health Officer of the district and to the State Department direct. Each of the State District Health Officers maintains a system of tabulation of reports for each disease from each city and town in his district in such a manner as to show at once any suspicious increase in the frequency of any disease.

Third. — As soon as the reports from the local boards of health are received in the Division of Communicable Diseases they are tabulated and charged against each city and town reporting. This tabulation is done on a specially devised card which is arranged so as to permit daily entries for each month in the year. On this card is recorded the average number of cases of each of the more serious communicable diseases reported by the city or town in the corresponding month for an average of five years previous, after all epidemics have been arbitrarily deducted. This system, which is called the endemic index, automatically calls to the attention of the Department even the slightest rise in frequency of the disease over the former condition. This rise in frequency is at once called to the attention of the State District Health Officer in whose district the situation occurs, and to the local board of health.

After giving all due credit to the alertness of the State District Health Officers, the automatic safeguards of the reporting system, and the public spirit of the medical profession in reporting promptly in the first place, undoubtedly the greatest reason for the noticeable increase in efficiency in the control of communicable diseases throughout the State from year to year is the constantly increasing efficiency of the local boards of health.

The statutes provide that the report of the work of this Department shall be for the fiscal year ending November 30. For many years past it has been customary, because of the fact that ample time elapsed before the publication of the report, to complete the morbidity statistical matter for the calendar year instead of for the fiscal year. This procedure has many obvious advantages. Inasmuch as under the present system of morbidity reporting and recording in this Division full reports of disease prevalence from the local boards of health are on file within two days from the end of the calendar year, and inasmuch as the present system of keeping records is so adjusted as to give the totals readily, the prevalence of the communicable diseases and their significance will be discussed hereafter on the basis of the statistics for the calendar year and not for the fiscal year.

Combined morbidity and mortality tables are of great value in the study of communicable diseases. Their usefulness is proportionately increased the earlier they are compiled. Heretofore it has been impossible to secure the data for such tables in time for current use for epidemiological work.

Death returns in this Commonwealth are made through the office of the Secretary of the Commonwealth. It is only fitting to state in this connection that for the year 1916, for the first time in the history of the Commonwealth, it is possible to give approximately accurate mortality statistics as well as morbidity statistics at the time of the publication of the report of the State Department of Health. This has been brought about entirely through the spirit of co-operation displayed by the office of the Secretary of State. Heretofore the mortality statistics for the Commonwealth of Massachusetts were compiled entirely with reference to completeness, and in the alphabetical order of the various cities and towns, but with no attempt to give early chronological statements. On pointing out to the Bureau of Vital Statistics the great importance to the Health Department's work of being able to know at the earliest possible date the fatality as well as the morbidity of all diseases dangerous to the public health, their entire system was readjusted in such a fashion as to give this Department a complete, detailed tabulation of the causes of death within a month from the date of their receipt in the office of the Secretary of State. As a result it has been possible to publish in the Monthly Bulletin of the Department for the first time the morbidity and mortality figures for all of the diseases dangerous to the public health within three months of the time of occurrence. Previously it was impossible to obtain mortality figures from either State Bureau of Vital Statistics or the Federal Census Bureau until nearly two years had elapsed. This has necessitated radical changes in routine methods of many years' standing in the State Bureau of Vital Statistics. The spirit of co-operation displayed by that department has been most gratifying.

Significance and Prevalence of Communicable Diseases.

The following table shows at a glance the total deaths from certain prominent communicable diseases and the percentage of mortality of these deaths to the total deaths from all causes for the State of Massachusetts for the year 1916, arranged in order of their proportionate fatality: —

DISEASE.	Number of Deaths.	Percentage of Total Deaths.
Pulmonary tuberculosis,	4,466	7.92
Lobar pneumonia,	3,694	6.55
Diphtheria,	629	1.12
Poliomyelitis,	452	0.80
Measles,	392	0.70
Whooping cough,	346	0.61
Typhoid fever,	172	0.31
Cerebrospinal meningitis,	136	0.24
Scarlet fever,	127	0.23
Smallpox,	–	–
Total,	10,414	18.48

This total is sufficiently large to indicate that much still remains to be done. In comparing these statistics with the records of the same diseases in 1895 a striking illustration is furnished of the great achievements of preventive medicine within the past generation. For the year 1895, with a total population a million and a quarter less, the total number of deaths recorded in Massachusetts from the same group of diseases was 13,589, representing 28.6 per cent. of the total mortality as against 18.48 per cent. for the year 1916.

The total number of diseases reported under the designation of "diseases dangerous to the public health" for the calendar year of 1916 in the Commonwealth of Massachusetts was 67,808. These cases were reported as follows, arranged in the order of the largest number of cases: —

Disease.	Number of Cases.	Disease.	Number of Cases.
Measles,	25,460	Cerebrospinal meningitis,	150
Pulmonary tuberculosis,	7,878	Dysentery,	119
Diphtheria,	7,282	Malaria,	97
Whooping cough,	6,447	Trachoma,	88
Scarlet fever,	6,271	Dog bite (suspected and known rabid dog).	71
Chicken pox,	4,672	Pellagra,	47
Mumps,	2,318	Tetanus,	34
Ophthalmia neonatorum,	1,736	Smallpox,	32
Anterior poliomyelitis,	1,927	Anthrax,	31
Typhoid fever,	1,515	Trichinosis,	24
Tuberculosis, other forms,	657	Actinomycosis,	4
German measles,	591	Leprosy,	2
Suppurative conjunctivitis,	196	Total,	67,808
Septic sore throat,	159		

This total falls slightly under the total reported for 1915 (71,900). There are good grounds for concluding that the reports are more complete now than ever before, or, in other words, that the smaller total as contrasted with last year does not mean a less complete degree of reporting but an actual lessened prevalence of these diseases as a group.

This is indicated by the comparative fatality percentage of the two years, and by the fact that the installation of improved methods of collection and compilation during the past year has disclosed and corrected certain errors of tabulation in previous years which had the effect of overstating the total number of cases.

The diseases showing pronounced increases compared with the reports of the previous year are as follows: —

Disease.	Number of Cases reported in 1915.	Number of Cases reported in 1916.	Increase.
Poliomyelitis,	135	1,927	1,792
Measles,	22,881	25,460	2,579
Anthrax,	11	31	20
Trichinosis,	0	24	24

The diseases showing pronounced decreases in prevalence when compared with the reports for 1915 are as follows: —

Disease.	Number of Cases reported in 1915.	Number of Cases reported in 1916.	Decrease.
Diphtheria,	9,282	7,282	2,000
Dog bite (known or suspected rabid dog),	174	71	103
Ophthalmia neonatorum,	2,894	1,736	1,158
Septic sore throat,	865	159	706
Typhoid fever,	2,204	1,515	689
Scarlet fever,	8,613	6,271	2,342

The figures for pulmonary tuberculosis (7,878) show a slight decrease over last year (8,046). Two serious sources of error in the previous reports of tuberculosis have been corrected during the present year by a system of careful individual recording of cases. The first error was the inclusion in previous years of a considerable number of cases as pulmonary tuberculosis that the present follow-up system has shown to be other than of the pulmonary type. The other reason for the apparent decline has been the elimination of pulmonary tuberculosis cases reported more than once from the same or different localities in varying periods of time, and a careful watch for variations in spelling in the names of the same cases. It is evident that this unconscious padding of the total number of tuberculosis cases reported in the past has amounted to some hundreds of cases per year in this State, and undoubtedly the same fallacy obtains in tuberculosis statistics in other communities unless individual case records are kept and a careful search is made to do away with these duplications.

Completeness of Reports.

Probably the most satisfactory method of determining the efficiency of the reporting of communicable diseases is the method known as case fatality percentage. An attempt is being made at the present time to establish in the United States a Federal morbidity registration area analogous to the area created by the Bureau of the Census for mortality and birth reports. The great difficulty has been to decide on some standard of reasonably complete reporting of diseases as gauged by the ratio between the number of reported cases and the deaths. For four common diseases — measles, scarlet fever, diphtheria and typhoid fever — for four consecutive years the average fatality percentage in the registration States has been, respectively, 1.74 per cent., 3.79 per cent., 9.9 per cent. and 16.7 per cent. It is certain that these averages are all too high because of the existence of unreported cases of diseases. It is interesting to note that in Massachusetts for the years 1915 and 1916 the apparent fatality percentage based upon the number of deaths and the number of reported cases for these four diseases is as follows: —

Disease.	Average of Registration States, 1912-14, inclusive.	Massachusetts, 1915.	Massachusetts, 1916.
Measles,	1.74	.64	1.5
Scarlet fever,	3.79	2.1	2.0
Diphtheria,	9.9	7.8	8.6
Typhoid fever,	16.7	11.1	11.4

These figures contrast very strikingly with the average for all of the registration States, showing a distinctly smaller apparent fatality rate for each disease in favor of Massachusetts. This would indicate that communicable diseases as a whole are being reported with a comparatively high degree of completeness throughout the Commonwealth.

Notable exceptions to this will be found in a few of the smaller towns that have no well-organized board of health or agent thereof, and in some of the lighter forms of disease where parents do not call the physician. Also a few of the diseases that have more recently been placed upon the reportable list have not yet become sufficiently fixed in the minds of the physicians to obtain uniform reporting. This is indicated in the group of towns of under 2,500 population, where we find for the year 1916 that only 99 cases of pulmonary tuberculosis were reported and 350 deaths. One town of 2,800 population has 2 deaths from measles and no case reported.

Epidemics, Outbreaks and Individual Diseases.

As a whole, the Commonwealth has been remarkably free from serious outbreaks of communicable diseases during the year 1916. The two great exceptions to this statement are the diseases poliomyelitis (infantile paralysis) and measles.

In a few towns there were no cases of poliomyelitis, and still a few other cities and towns had no more cases than their average for the last few years; but in general, the disease may be considered to have prevailed in a State-wide epidemic of most unusual proportions.

There have been various other outbreaks and epidemics of less importance that have been investigated, and concerning which special reports have been submitted. Condensed details of these will be found in the Appendix. There were 20 localized outbreaks of measles, 18 outbreaks of scarlet fever, 20 outbreaks of diphtheria, 7 outbreaks of whooping cough, 6 outbreaks of typhoid fever (that in Lynn being of considerable size), 1 outbreak of smallpox and 1 of anthrax. They were variously classified as being due to contact with mild cases, school contact, institutional, carriers and milk.

During the year there have been several institutional outbreaks in which the services of the State Department of Health have been solicited. These have been investigated either by the District Health Officers or the epidemiologist.

A study of these leads us to believe that communicable diseases in these institutions constitute a factor of sufficient importance to warrant adequate provision being taken to guard against their gaining a foothold; also to care for them when they exist. We would recommend —

1. A careful and complete history of previous communicable diseases.
2. Observation quarters where new admissions may be kept for a period of two weeks before mingling with the rest of the institution. This is frequently done for mental condition. Medical tests and observations could be done at the same time.
3. Keeping the inmates in units so far as is consistent with efficient administration.
4. Adequate isolation hospital provisions.
5. Immunization against typhoid and other diseases common to this region for which immunization methods have been satisfactorily worked out.

In 1916 institutional outbreaks were confined mainly to scarlet fever and diphtheria, the latter leading with a record of 8 outbreaks with

89 clinical cases and 134 cultural cases involving 223 people. Scarlet fever occurred in only 2 institutions, affecting but 11 people. Diphtheria occurred at the Industrial School at Shirley, at the Baldwinsville cottage hospitals, Phillips Academy at Andover, the Framingham Hospital, the Massachusetts General Hospital at Boston, Holyoke City Hospital, the Schools for Feeble-Minded at Wrentham and Waltham and the Westfield State Sanatorium.

Actinomycosis. — Four cases of this infection have been reported during the year, — one each from Lowell, New Bedford, Winchendon and Boston.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	1	–	.03	–
1913, ...	3,576,174	3	3	.08	.08
1914, ...	3,641,553	4	2	.11	.06
1915, ...	3,706,931	8	4	.22	.11
1916, ...	3,779,033	4	–	.11	–

Anthrax. — An outbreak of anthrax occurred among the tannery workers of Woburn and Winchester. In this outbreak were 30 cases, an unusually large number for the United States, all found to be traceable to a single shipment of imported infected hides. This Department has called attention to the industrial hazard involved in the handling of imported hides under present conditions to the Federal authorities concerned, urged a revision and more thorough enforcement of the Federal regulation governing hide importation, and, in co-operation with the State Board of Labor and Industries, has advised the leather manufacturers to adopt precautions against infection within their plants. A detailed report by the epidemiologist on this most interesting and serious outbreak can be found in the Appendix to this report.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	11	2	.31	.06
1913, ...	3,576,174	8	3	.22	.08
1914, ...	3,641,553	8	1	.22	.03
1915, ...	3,706,931	11	4	.30	.11
1916, ...	3,779,033	31	5	.82	.13

Anterior Poliomyelitis. — The outbreak of poliomyelitis in Massachusetts was distinctly secondary to the great outbreak in New York City which began in the early summer and gradually spread to adjacent territory. The remainder of New York State, New Jersey, Pennsylvania, Connecticut, Rhode Island, Maryland and Massachusetts all reported very extensive prevalence of the disease. The maximum effect of the outbreak, or the "peak," came distinctly later in Massachusetts than in any of the other States seriously affected, except Maryland, not reaching its maximum until October, whereas in all the other States seriously affected, except Maryland, which also reported the heaviest prevalence in October, the active phase of the epidemic occurred in August or September.

The total number of cases reported for the Commonwealth for the year was 1,927, which number is more than twice as great as for the year of greatest previous known prevalence, 1909. Of this total 1,861 were reported between July 1 and December 1, to which months the epidemic prevalence of the disease may be properly restricted.

The total number of cities and towns reporting one or more cases during the year was 201, out of a total of 354. This indicates a more widespread infection as well as a larger number of cases than in any previous year. In fact, the present epidemic is in sharp contrast with all earlier experiences in the State in respect to its widespread character throughout the Commonwealth.

The total fatalities reported were 452, which gives a fatality percentage of 23.5.

Certain cities and towns showing unusually high rates of prevalence are as follows: —

Cases and Case Rates per 100,000 Population of Cities and Towns having 15 or more Cases of Poliomyelitis in 1916.

TOWN.	Cases.	Case Rate.	TOWN.	Cases.	Case Rate.
Dalton, ...	17	433.0	Everett, ...	29	74.9
Amesbury, ...	22	268.0	Cambridge, ...	72	65.6
Holyoke, ...	116	188.2	Boston, ...	491	64.4
North Adams, ...	38	172.4	Brookline, ...	21	60.2
Pittsfield, ...	67	161.9	Medford, ...	19	58.9
Dedham, ...	18	157.1	Revere, ...	15	55.8
Quincy, ...	66	155.0	Somerville, ...	48	53.9
Newburyport, ...	22	143.0	Chicopee, ...	15	47.9
Adams, ...	15	113.2	Newton, ...	21	47.8
Beverly, ...	23	100.1	Lynn, ...	44	45.2
Melrose, ...	17	99.0	New Bedford, ...	19	16.9
Malden, ...	46	92.1	Lowell, ...	17	15.7
Waltham, ...	27	88.0	Worcester, ...	24	14.4
Springfield, ...	89	83.6			

This Department is now carrying out detailed epidemiological studies on the data collected by the District Health Officers and special investigators of the Department at the time of the epidemic. The results of this study will be published as a special report at an early date. Preceding this detailed report the following brief sketch of the progress of the epidemic gives the most pertinent features.

Previous to July a few scattering cases of this disease had appeared, largely in the Southeastern District, in and about New Bedford. The real outbreak, however, began in the Berkshire district in the town of North Adams. These first cases can apparently be definitely traced to New York, as they occurred in children but recently arrived from that city.

During this month poliomyelitis extended to the Connecticut Valley, Westfield reporting 10 cases and Springfield 6; other scattering cases also occurred. Farther east there were cases at Worcester, Dudley, Webster and Fitchburg. Along the coast the cases during this month were largely grouped about Fall River (5) and New Bedford (10).

With the coming of August a marked increase in the number of cases was to be noted throughout the State. North Adams and Pittsfield were the storm centers for the Berkshire district, with 20 cases in the former city and 10 in the latter. Continuing to the Connecticut Valley we find 17 cases occurring during this month in Springfield, 7 in Holyoke, 5 in Easthampton and 6 in Montague. Scattering cases appeared along through the South Midland District, 5 of which occurred in Worcester. The northeastern section of the State showed cases, especially in Haverhill, where 6 occurred. The Eastern District now for the first time began to report cases of poliomyelitis in any number; Cambridge showed 6 and Boston 34. In the Southeastern District 4 cases occurred in quick succession in one town, — Wareham, — with 3 deaths. No autopsies were performed on these 3 fatal cases.

During September the disease continued in the Berkshires with the central point at Pittsfield (32 cases). Adams and North Adams had, respectively, 5 and 8 cases. In the Connecticut Valley 59 cases appeared in Holyoke, 8 in Chicopee and 4 in West Springfield. Coming east, Warren and Worcester had, respectively, 5 and 7 cases. The northeastern section suffered, with 9 cases in Amesbury, 18 in Malden, 13 in Newburyport and 8 in Beverly.

Boston and the surrounding cities and towns were hard hit, Boston alone having 172 cases. Quincy showed 12, Cambridge 14 and Somerville 10 cases.

The Southeastern District escaped almost entirely during the month.

The following month, October, saw a slight diminution in the appearance of poliomyelitis in the west. Pittsfield had 22 cases, while scattering cases occurred in other neighboring towns. The month's cases in the Connecticut Valley centered about Holyoke (35), Springfield (14), Chicopee (4), South Hadley (5) and Conway (4), with more or less of the disease in neighboring towns. The central districts of the State showed few cases, Waltham having the largest number (20). The northeastern cases centered chiefly at Lynn (25), Wakefield (7), Melrose (14), Malden (17) and Everett (16). The Eastern District showed a great increase of cases, Boston leading with 229 cases, Quincy with 45, Brookline with 12, Cambridge with 36 and Dedham with 10. Having swept over the State the disease showed unmistakable signs of abatement. On looking back over the incidence of cases in the different towns of the Commonwealth several striking instances may be seen of exemption from the ravages of this malady. Noteworthy among these is the city of Brockton with only 3 cases in two families. Other smaller places have had only one or two cases, these occurring sometimes early in the epidemic. Some towns have put into practice stringent regulations aimed at control without much apparent advantage in point of number of cases over adjoining towns which have made less use of restrictive measures.

The District Health Officers in their advice to the town authorities have urged moderation and calmness, and have tried to prevent unnecessary hardship being laid upon the traveling public through unduly stringent restriction regulations.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	169	76	4.8	2.2
1913, ...	3,576,174	361	69	10.1	1.9
1914, ...	3,641,553	151	45	4.1	1.2
1915, ...	3,706,931	135	32	3.6	0.8
1916, ...	3,779,033	1,927	452	51.0	12.0

Chicken Pox. — This disease has been reported at about its usual rate during this year. At no time is its death rate high enough to make it of importance from this standpoint. When an outbreak of chicken pox is accompanied by several deaths the question of diagnosis should be investigated; mild smallpox and severe chicken pox are with difficulty distinguished from each other, and a mistake may be a serious matter. An instance of this kind was found in the Great Barrington and Lee epidemic.

Year.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	3,574	–	101.8	–
1913, ...	3,576,174	3,822	2	106.9	.06
1914, ...	3,641,553	4,896	3	134.4	.08
1915, ...	3,706,931	5,512	5	149.0	.13
1916, ...	3,779,033	4,672	5	123.6	.13

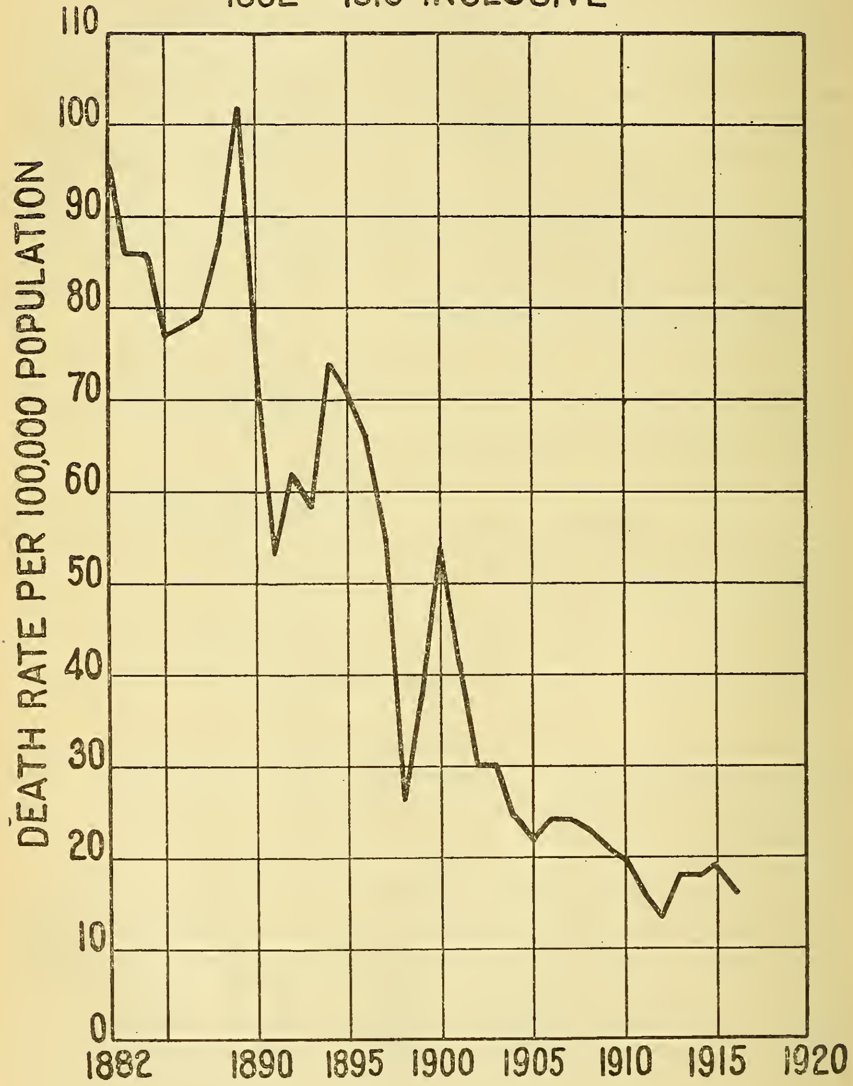
Diphtheria. — Of peculiar interest was a continued outbreak of diphtheria in the State Industrial School for boys at Shirley. The original case occurred in June, 1915, followed by a period of some months of apparent freedom from the disease. It recurred and continued throughout the first part of 1916. This outbreak was prolonged and a source of great inconvenience to all concerned. Early and liberal use of antitoxin averted fatalities and rendered the entire outbreak mild in character, but persistent carriers and inadequate means of isolation extended and complicated the outbreak, and rendered effective administrative control almost impossible.

In December, 1915, a small epidemic due to direct contact occurred in Amherst consisting of 32 cases in all. A peculiar feature of this outbreak was the occurrence of a small "sub-epidemic" of 5 cases, in which the disease was transmitted by milk.

The diphtheria situation in Fitchburg has been noteworthy throughout the year, the disease having been continually prevalent, but not at any time reaching the proportions of a distinct epidemic. Diphtheria exceeded its endemic index, or, in other words, its normal prevalence in this city every month in the year, with the exception of April, cases being unusually numerous in January, February and March. This outbreak also was a direct continuation of an outbreak beginning in 1915.

A number of other distinct outbreaks, 19 in all, occurred in various localities during the year. A tabulation, with a brief synopsis of each outbreak, has been prepared by the epidemiologist and is printed in the Appendix.

Year.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	5,433	473	154.8	13.5
1913, ...	3,576,174	6,741	628	188.5	17.6
1914, ...	3,641,553	8,080	652	221.9	17.9
1915, ...	3,706,931	9,282	721	250.4	19.4
1916, ...	3,779,033	7,282	629	192.7	16.6



THE COMMONWEALTH OF MASSACHUSETTS
STATE DEPARTMENT OF HEALTH
DIPHTHERIA
1882 – 1916 INCLUSIVE

Dog Bite. — Of the 71 cases of "dog bite" officially reported, investigation showed that in but 24 was there any need of antirabic treatment. These were bitten by (*a*) one cat that was found by laboratory examination to have had rabies; (*b*) one dog that was suspicious; and (*c*) seventeen dogs that were found positive for rabies. Of these 24 people 22 received antirabic treatment, 2 being treated by New York City virus, 1 going to the Pasteur Institute for treatment and 19 being treated by the Department. Five other people bitten by dogs not found rabid were given treatment, as they preferred it for various reasons. There were no deaths.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1915, ...	3,706,931	174	5	4.7	.14
1916, ...	3,779,033	24	–	.6	–

Dysentery (*Bacillary*). — Two outbreaks of this disease occurred during the year. The first was a sharp and particularly virulent outbreak in a children's institution in Haverhill beginning in July. A total of 13 cases was reported with 2 deaths. For special report by the epidemiologist, including secondary infection in Dedham, see Appendix.

Another small but very serious focus of bacillary dysentery, in which all cases were confined to one family, occurred in Natick in July and August. There were 6 cases and 3 deaths. In both of these outbreaks the character of the infection was confirmed bacteriologically.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1915, ...	3,706,931	238	92	6.5	2.4
1916, ...	3,779,033	119	83	3.1	2.2

Epidemic Cerebrospinal Meningitis. — Epidemic cerebrospinal meningitis has not been unusually prevalent during 1916. The high fatality rate of this disease renders it an important public health problem. The differential diagnosis is now usually made by spinal puncture and laboratory examination of the fluid. The treatment by Flexner serum is nearly universal.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	202	138	5.8	3.9
1913, ...	3,576,174	180	147	5.0	4.1
1914, ...	3,641,553	181	156	5.0	4.3
1915, ...	3,706,931	145	125	3.9	3.4
1916, ...	3,779,033	150	136	4.0	3.6

German Measles. — German measles is of importance to the public health official by reason of its resemblance to the more serious eruptive disease. The confusion of this disease with measles, or, what is more likely, scarlet fever, may result in serious consequences.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1915, ...	3,706,931	500	1	13.5	.03
1916, ...	3,779,033	591	1	15.6	.03

Leprosy. — Two cases were reported during the year, 1 from Boston and 1 from Woburn. One of these cases was returned to his home in Cuba; the other was sent to Penikese.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	4	1	.11	.03
1913, ...	3,576,174	2	1	.06	.03
1914, ...	3,641,553	1	1	.03	.03
1915, ...	3,706,931	2	1	.05	.03
1916, ...	3,779,033	2	2	.05	.05

Malaria. — Malaria is poorly reported and hard to classify as to whether it is a primary case or the starting up of a dormant infection. There is no denying the fact that there are certain localities in Massachusetts that harbor the infective anopheles, although the way to be rid of them has long been known.

Deaths from this disease seldom occur in Massachusetts, but the efficiency of the individual is frequently much reduced.

Considerable work is carried on in many places to eliminate the mosquito as a nuisance from the community, but little, if any, systematic operations have been undertaken in this line as a health measure. The amount of malaria reported in the State in the past years is shown in the following table: —

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1915, ...	3,706,931	112	6	3.0	.16
1916, ...	3,779,033	97	4	2.6	.11

Measles. — Measles is the most important quantitative factor in communicable disease reports for the year, contributing 38 per cent. of all reported cases. A study of the table will show that in each of the last five years it has been epidemic in the Commonwealth. This year has been no exception to the rule.

The importance of this infection is greatly underestimated. The general public still considers it a harmless disease, and this feeling is shared by even some public health officials. Consequently, very little consistent effort is made to prevent the extension of this disease. Indications from the study of institutional outbreaks, where careful isolation measures can be enforced, do not bear out this idea.

The fatalities from measles reach over 200 in the average year, and approximately 400 in 1916. These figures do not represent accurately the harm done by this infection. A great many death certificates which are signed giving the cause of death as acute bronchitis and broncho-pneumonia, with measles as a secondary cause, should be charged to this infection. It is an established fact that measles is very often a predisposing cause to tuberculosis in children.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	22,423	286	638.7	8.2
1913, ...	3,576,174	29,192	315	816.3	8.8
1914, ...	3,641,553	12,264	149	336.8	4.1
1915, ...	3,706,931	22,881	149	617.2	4.0
1916, ...	3,779,033	25,460	392	673.7	10.4

Mumps. — Mumps is of comparatively little importance as a communicable disease, although an occasional case is serious. It has been reported in about the same amount as in 1915.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1915, ...	3,706,931	2,128	1	57.4	.03
1916, ...	3,779,033	2,318	3	61.3	.08

Ophthalmia Neonatorum. — Perhaps in no other disease, in the list of diseases dangerous to the public health, have the efforts of this Department produced such gratifying results as in ophthalmia neonatorum. As a result of the utilization of the prophylactic, and the increasingly more prompt interest in these cases shown by the local boards of health, an interest fostered and stimulated constantly by the District Health Officers, the end results of these infections are becoming more satisfactory, and their total amount is decreasing rapidly. During 1916, 1,736 cases of ophthalmia neonatorum were reported, a decrease of nearly 1,200 compared with the previous year. Furthermore, in the past year only two cases of blindness as a result of ophthalmia neonatorum have come to the attention of this Department.

The number of such cases reported for the last five years is as follows: 1912, 22; 1913, 15; 1914, 12; 1915, 4; 1916, 2.

In the following table for ophthalmia in previous years suppurative conjunctivitis is included: —

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	1,750	–	49.9	–
1913, ...	3,576,174	2,304	5	64.4	.14
1914, ...	3,641,553	2,620	–	72.0	–
1915, ...	3,706,931	2,894	–	78.1	–
1916, ...	3,779,033	1,932	–	51.1	–

Pellagra. — Forty-seven cases of this disease were reported during the year, of which 26, or 59 per cent., occurred in institutions.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1915, ...	3,706,931	33	26	.9	.7
1916, ...	3,779,033	47	37	1.2	1.0

Scarlet Fever. — Relatively few outbreaks of scarlet fever were reported during the year. In only one of these was the total number of cases large. This outbreak, of 187 cases, occurred in Quincy and was somewhat prolonged in character, the cases being reported rather uniformly throughout the first five months of the year. The outbreak appeared to be due to unrecognized carriers among the school population, and concealed cases.

The one other outbreak of special interest was a small one in Clinton, probably due to infected milk on the route of one milkman. Ten cases were reported in May. In the Appendix a tabulation of the other outbreaks can be found.

Year.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	5,633	118	160.4	3.4
1913, ...	3,576,174	8,062	293	225.4	8.2
1914, ...	3,641,553	11,057	246	303.7	6.8
1915, ...	3,706,931	8,613	182	232.3	4.9
1916, ...	3,779,033	6,271	127	166.0	3.4

Septic Sore Throat. — Only one small outbreak of this disease occurred during 1916. This was in Watertown in May. In this outbreak an investigation disclosed a young man on a dairy farm who had practically no constitutional symptoms, but a culture from a sore throat showed the specific cocci. Also pus squeezed from an atrophied but inflamed quarter in one of the cows contained the specific organism. On Monday the man was removed, the milk from this cow was discarded, and pasteurization of the whole supply was commenced. The last case was reported the following Friday.

There is certainly something wrong in the statistics of this disease for 1916, as 67 deaths with 159 cases reported is entirely out of proportion to the expected fatality rate. Either there has been a flagrant lack of reporting, or the cause of death in many of the cases has been erroneously determined. Probably the latter is mostly responsible, as they were scattered through the State. The complete bacteriological determination of this disease is not yet practical in the ordinary diagnostic laboratory. Scarlatina anginosa might readily be confounded with septic sore throat in the absence of known scarlet fever contacts, as might also some cases of diphtheria where the membrane is located in places other than the pharynx.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1915, ...	3,706,931	865	-	23.4	-
1916, ...	3,779,033	159	67	4.2	1.8

Smallpox. — Two smallpox outbreaks occurred during this year, one consisting of 11 cases in Fitchburg, in March, April, May and June, and another consisting of 18 cases in Lee and Great Barrington in October and November. In both instances the outbreaks were traced to a single source of infection, and both were promptly suppressed by the local authorities. Single cases occurred in Lowell, Chicopee and Boston.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	220	1	6.3	.03
1913, ...	3,576,174	157	-	4.4	-
1914, ...	3,641,553	38	-	1.0	-
1915, ...	3,706,931	24	9	.6	.24
1916, ...	3,779,033	32	-	.8	-

Suppurative Conjunctivitis.—Suppurative conjunctivitis was reported in 196 cases. The ordinary forms of this class of cases are probably not yet well reported, but we expect they will be greatly reduced with the disappearance of the common towel.

It has been apparent from the first that many cases so reported were really cases of ophthalmia neonatorum.

Tetanus. — Thirty-four cases were reported during the year.

This is one of the rarer communicable diseases. That it should be of so rare occurrence is rather remarkable in view of the fact that its spores are common enough to call for careful technique and prophylactic treatment in many classes of injuries.

Of the 31 fatal cases 2 were infected through the umbilical cord at birth. In one a diagnosis of poliomyelitis had been made.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	24	27	.7	.8
1913, ...	3,576,174	23	33	.6	.9
1914, ...	3,641,553	31	28	.9	.8
1915, ...	3,706,931	32	33	.8	.9
1916, ...	3,779,033	34	31	.9	.8

Trachoma. — Eighty-eight cases were reported to this Department from local boards of health, or from the Massachusetts Charitable Eye and Ear Infirmary. A number of cases reported by the latter institution had not previously come within the knowledge of the local boards. This probably can be explained by the fact that owing to the reputation of the Eye and Ear Infirmary many suffering from eye trouble go there directly without consulting local physicians at all.

Those who know about this disease, or have had experience in eye clinics, have no hesitancy in saying that trachoma in Massachusetts is much more prevalent than is indicated by the number of cases reported. Many patients do not have a physician, while many other cases are unrecognized or unreported.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	46	–	1.3	–
1913, ...	3,576,174	112	–	3.2	–
1914, ...	3,641,553	68	–	1.9	–
1915, ...	3,706,931	50	–	1.4	–
1916, ...	3,779,033	88	–	2.3	–

Trichinosis. — An outbreak of 11 cases occurred in Springfield in November, all of which were traced to the consumption of an infected carcass distributed among several Italian families.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	10	3	.28	.09
1913, ...	3,576,174	5	4	.14	.11
1914, ...	3,641,553	5	3	.14	.08
1915, ...	3,706,931	–	–	–	–
1916, ...	3,779,033	24	3	.64	.08

Tuberculosis, Pulmonary. — As measles is the most important factor in the incidence of communicable disease, so is pulmonary tuberculosis the most important factor in the number of deaths from this group of diseases. In 1916 pulmonary tuberculosis represented 56 per cent. of the deaths in this group.

This disease continues to be the most serious problem among the communicable diseases. Its insidious onset and slow progress make its control most difficult. This disease has been reported to the Department in slightly less amount than in 1915, although the number of deaths have been somewhat increased. The nature of the disease is such that the epidemiological work in combating it must be of a very different method than that used with many of the other communicable diseases. There are no epidemics to report. It does not appear in that form in a country already peppered with it. To successfully combat it there must be awakened a permanent and comprehensive public sense of danger and spirit of co-operation; a larger force of enthusiastic workers and considerable sums of money are also needed. The clerical end of this fight is of especial importance and one difficult to impress on workers in general. The fact that it is imperative to know where each active case and its contacts are located does not seem as important to them as it should. It is necessary to constantly insist that the disease is communicable from person to person, as diphtheria is, and is to be feared from the same viewpoint, and fought in many respects along similar lines. Local health authorities must constantly know the location and habits of the cases, that they may exercise the necessary control of the infection.

The tuberculosis dispensaries are working out their local problems with varying degrees of efficiency. In the great majority of dispensaries most excellent work is being done, and eventually their work will produce a fund of information and an improved technique of administration that will be invaluable in the future tuberculosis campaign, in addition to the immediate benefits obtained by the services of the dispensaries for the individual cases of consumption under their care at the present time. The District Health Officers are constantly aiding the local dispensaries.

In some localities antituberculosis dispensaries were in active and successful operation prior to the enforcement of the Acts of 1911, chapter 576, with its amendments. In a few, which came under the provisions of the law establishing them, there was passive if not active opposition. They were established throughout the State as the law provided, and in only one or two was a suggestion of coercion necessary.

The Department has felt that the success of any given dispensary depends in a large measure on the personality and the special ability of the so-called "dispensary nurse," be she lay worker or trained;

therefore the efforts of the Division have been focused on her as the central working unit. Meetings of the dispensary nurses have been held at intervals through the winter under the leadership of the director of Division of Communicable Diseases and Miss Beard, director of the Boston Instructive District Nursing Association, to which members of boards of health and dispensary physicians have been urged to come. Most of the boards of health have sent their nurses to these meetings with gratifying regularity, but have not come themselves as frequently as was hoped. The subjects discussed at these meetings, and the interchange of ideas and methods, have been of great service in the work, and the members of local boards who have not attended have lost many an opportunity for learning methods for improving conditions in their communities.

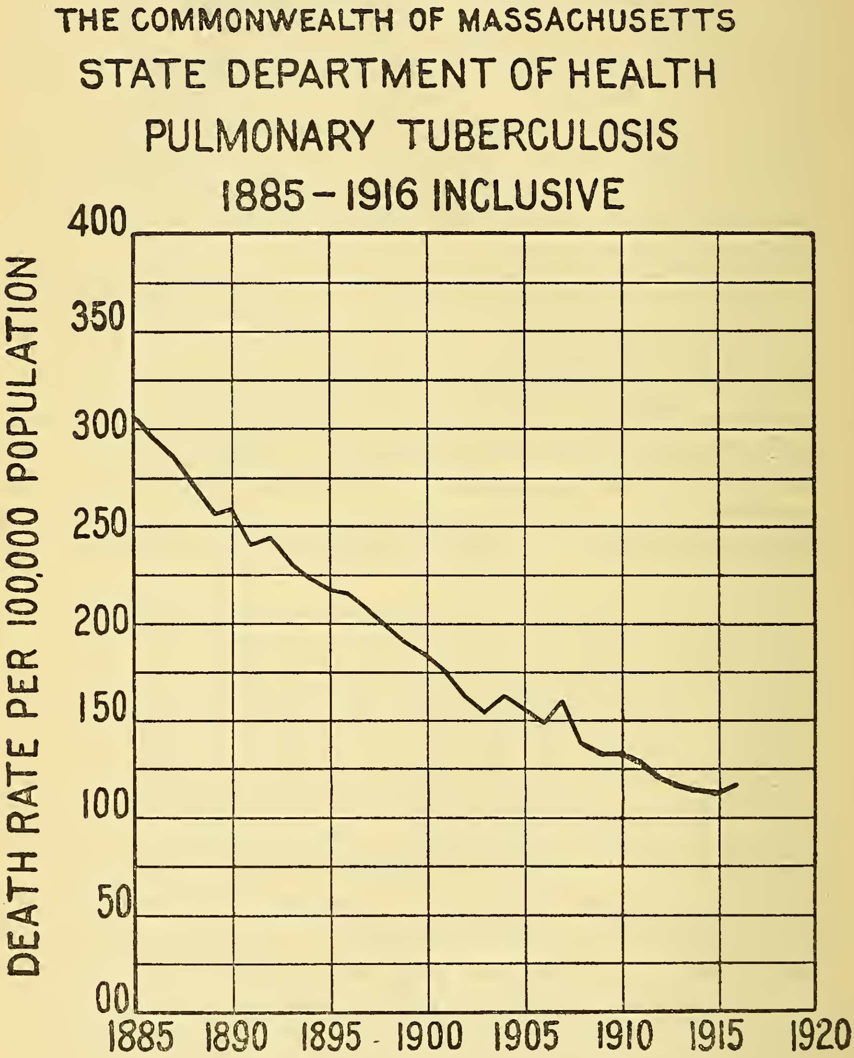
In some localities experience has shown that the original location or personnel of the force could be advantageously changed, and such changes have been made.

Some of the unsettled questions of detail of management and equipment are as follows: It seems better in most cases to have rooms used by the dispensary alone, not rooms shared by some other association or used as a private physician's office. In some places it seems more successful to have many physicians taking their turn in charge of the dispensary; in others it is better to appoint one to take permanent charge..

In general, the control of dispensaries is under the control of the local board of health; a few are under the control of local societies. It seems logical to expect more successful work when the authority of the board of health is directly back of it, although some of the very successful dispensaries of the State are under the control of societies.

A full-time "dispensary nurse" is, of course, essential where there is a sufficient volume of work. Where there is a smaller amount to do various combinations are in evidence. The combining of the duties of a "district nurse" with those of a "dispensary nurse" seems as a rule less successful than combining the functions of a "board of health nurse" with those of a "dispensary nurse." A number of local boards have secured the services of a part-time "board of health nurse" by such an arrangement, and have demonstrated the value of the "board of health nurse" to their community. Combining the functions of a part-time "school nurse" with those of a "dispensary nurse" has also proved successful.

The enactment of the county tuberculosis hospital law has made it necessary for each of the District Health Officers to devote much time to the study of the problems incidental to the establishment of these hospitals, as technical advisers to the county commissioners in their respective districts. The general result of this study has been to reduce the number of hospitals planned to the minimum number which it is believed will give the amount of tuberculosis hospital service that the needs of the State require. The increasing amount of time that these more comprehensive duties of the District Health Officers demand



has resulted in a diminished amount of work on their part upon individual cases of tuberculosis. This result is inevitable. Originally, it was planned to have the District Health Officers visit all cases of tuberculosis that are not under the supervision of the city and town tuberculosis dispensaries, but in actual practice it has been impossible to do so. Other duties that are relatively more important demand their entire time. Well-trained nurses could do much of this work under the general direction of the District Health Officers and so save the time of the District Health Officers for specialized investigations. The need of such a type of assistance for the District Health Officers was emphasized in last year's report, and the experience of the past year has rendered the need of such service more pressing than ever.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	7,519	4,212	214.2	119.9
1913, ...	3,576,174	7,424	4,180	207.6	116.9
1914, ...	3,641,553	7,144	4,171	196.2	114.5
1915, ...	3,706,931	8,046	4,194	217.0	113.1
1916, ...	3,779,033	7,878	4,466	208.5	118.2

Tuberculosis, Non-pulmonary. — Non-pulmonary tuberculosis is a much larger public health factor in this Commonwealth than is generally realized, either by the public or physicians.

A report to the Legislature on the conditions throughout the State in regard to the number of cases, hospital facilities and requirements, and the best location for such accommodations, is printed with other legislative subjects in the Appendix.

From this it will be seen that while there are a large number of cases in the State, but few of them are reported, and only a small percentage is receiving the special attention that their disease requires. This condition exists up to the present time, although there are two institutions in the State that are well situated and equipped to care for such cases, and neither is running to its full capacity. That it plays no small part in the death toll of our community, and in the near future should receive more attention, can be seen by reference to the mortality table (see page 222), where it will be found to stand second only to pulmonary tuberculosis among our communicable diseases.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912, ...	3,510,795	477	855	13.6	24.4
1913, ...	3,576,174	412	869	11.4	24.1
1914, ...	3,641,553	570	890	15.7	24.7
1915, ...	3,706,931	822	853	22.2	23.0
1916, ...	3,779,033	657	955	17.4	25.3

Typhoid Fever. — The continued reduction of the death rate in typhoid fever is very gratifying. In 1916 it reached the low mark of 4.6 per 100,000.

The first outbreak, which, strictly speaking, belongs in the previous year's report, as the cases occurred in November, 1915, consisted of an outbreak of 21 cases at Ashburnham. The cause of this outbreak was obscure; neither milk supply, water supply nor contact could be definitely proved.

In Fall River, in December, 1915, and January, 1916, there were 38 cases due to a milk infection originating from a dairy farm in Tiverton, R. I.

A small outbreak of 6 cases due to milk occurred in Nantucket in August. A positive culture was obtained in the State laboratory from one of the milk handlers.

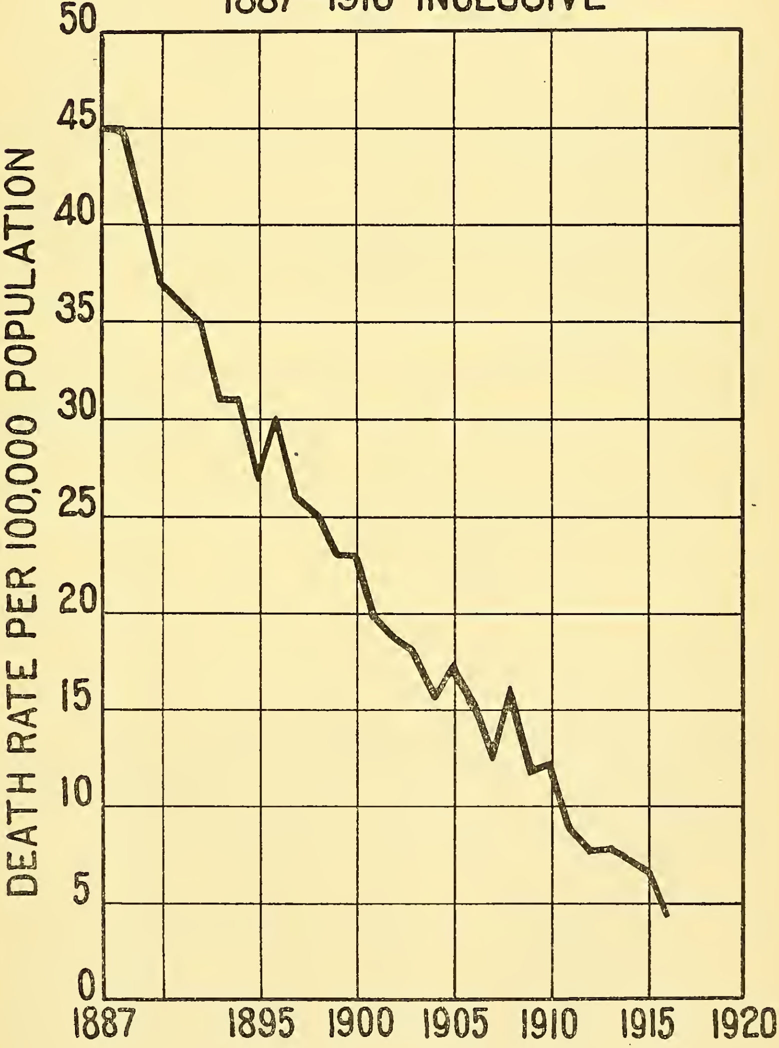
The largest epidemic of the year was in Lynn, — 114 cases between August 28 and September 30. In this instance, although the epidemiological evidence is conclusive that milk was the source, a positive carrier could not be proved, although most careful investigations were made with that end in view. A special report on the Lynn outbreak by the epidemiologist can be found in the Appendix to this report.

An outbreak of 4 cases in Whitman in August and September occurred on a milk route. The milk dealer proved to be the carrier, and a positive culture was obtained in the State laboratory.

In Scituate there was a most interesting clearing up of a mysterious occurrence of sporadic cases which has continued over a period of seventeen years, all finally proved to have been due to a man who only rarely sold milk to his immediate neighbors. A positive culture was obtained from him also in the State laboratory.

A tabulation of all typhoid outbreaks by the epidemiologist is also printed in the Appendix.

THE COMMONWEALTH OF MASSACHUSETTS
STATE DEPARTMENT OF HEALTH
TYPHOID FEVER
1887-1916 INCLUSIVE



YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912,	3,510,795	2,088	269	59.5	7.7
1913,	3,576,174	2,398	280	67.0	7.8
1914,	3,641,553	2,333	268	64.1	7.4
1915,	3,706,931	2,204	247	59.5	6.6
1916,	3,779,033	1,515	172	40.1	4.6

Whooping Cough. — Although this disease was not prevalent in nearly as widespread form as measles, it exhibited its usual State-wide distribution. The localities in which an unusual number of cases of this disease was reported, in proportion to the average number for the past five years, were Brockton, Cambridge, Lexington, Mansfield, Melrose, Needham, Sheffield and Wellesley. A tabulation of the more important or peculiarly interesting outbreaks of whooping cough is included in the Appendix.

YEAR.	Population.	Cases.	Deaths.	Case Rate per 100,000 Population.	Death Rate per 100,000 Population.
1912,	3,510,795	3,112	225	88.6	6.4
1913,	3,576,174	3,325	239	93.0	6.8
1914,	3,641,553	3,316	225	91.1	6.2
1915,	3,706,931	7,182	283	193.7	7.6
1916,	3,779,033	6,447	346	170.6	9.2

Table of Communicable Diseases in the Order of the Number of Deaths.

DISEASES.	Cases.	Deaths.	Case Rate per 100,000.	Death Rate per 100,000.
Pulmonary tuberculosis,	7,878	4,466	208.50	118.20
Other forms of tuberculosis,	657	955	17.40	25.30
Diphtheria,	7,282	629	192.70	16.60
Anterior poliomyelitis,	1,926	452	51.00	12.00
Measles,	25,460	392	673.70	10.40
Whooping cough,	6,447	346	170.60	9.20

Table of Communicable Diseases in the Order of the Number of Deaths — Concluded.

Diseases.	Cases.	Deaths.	Case Rate per 100,000.	Death Rate per 100,000.
Typhoid fever,	1,515	172	40.10	4.60
Cerebrospinal meningitis,	150	136	4.00	3.60
Scarlet fever,	6,271	127	166.00	3.40
Dysentery,	119	83	3.10	2.20
Septic sore throat,	159	67	4.20	1.80
Pellagra,	47	37	1.20	1.00
Tetanus,	34	31	.90	.80
Malaria,	97	4	2.60	.11
Chicken pox,	4,672	5	123.60	.13
Anthrax,	31	5	.80	.13
Mumps,	2,318	3	61.30	.08
Trichinosis,	24	3	.60	.08
Leprosy,	2	2	.05	.05
German measles,	591	1	15.60	.03
Ophthalmia neonatorum,	1,736	–	46.00	–
Suppurative conjunctivitis,	196	–	5.20	–
Trachoma,	88	–	2.30	–
Dog bite,	71	–	1.80	–
Dog bite by rabid animals,	24	–	.60	–
Smallpox,	32	–	.80	–
Actinomycosis,	4	–	.11	–

IV. THE GREAT COMMUNICABLE DISEASE PROBLEMS OF THE COMMONWEALTH.

The largest communicable disease problems that confront the State and local departments of health of the Commonwealth, arranged on a basis of their percentage importance as causes of mortality in the year 1915, are as follows: —

Pulmonary tuberculosis.
Lobar pneumonia.
Diphtheria.
Whooping cough.
Measles.
Scarlet fever.
Typhoid fever.

The first three have consistently led in the death returns, in the order mentioned, for many years. Scarlet fever, whooping cough and measles show very pronounced variations in the number of deaths from year to year, but they are constantly among the most serious communicable disease problems. Typhoid fever has steadily decreased as a cause of mortality for a long series of years. If true returns of the fatalities from syphilis could be obtained, this disease likewise would take rank as a cause of death in the first half of this table of diseases, and if syphilis is added to the group it is safe to state that the eight diseases represent over 95 per cent. of the total communicable disease problem of the State.

Basing the comparison entirely on the relative number of deaths does not accurately represent the true relative weight of these different diseases as public health problems. In some of them, for example, scarlet fever, the amount of initial morbidity impairment and the total amount of subsequent bodily impairment, due to sequellæ and late complications, create a public health problem that is not accurately represented by the total number of immediate deaths. In certain others, as tuberculosis and syphilis, the chronicity of the disease process and the consequent long drawn out possibilities of infection of other individuals add materially to the importance and complexity of the problem.

Two of the diseases above enumerated, lobar pneumonia[1] and syphilis, have not as yet been added to the list of diseases declared notifiable to this Department as diseases dangerous to the public health. All of the other diseases have been so notifiable for many years.

1. *Pulmonary Tuberculosis.* — Pulmonary tuberculosis occupies the first place as a communicable disease problem throughout the world. This is true in this State on a basis of the number of deaths from the disease compared with deaths from all of the other communicable diseases. It is still more true from the economic and social impairment that the disease produces, from the obscurity which still surrounds the precise manner of infection, and particularly from the standpoint of the amount of money and energy that is already being devoted to attacks upon the disease.

The following factors may be considered as essential to any well-developed campaign against tuberculosis: —

(*a*) Protection against tuberculosis infection through food.

(*b*) Prompt and complete reporting of the disease, supplemented by good laboratory, hospital, dispensary and other scientific facilities for diagnosis and comprehensive follow-up methods.

(*c*) Adequate institutional facilities for the treatment of the disease.

(*d*) Special supervision over the hygiene, environment and nutrition of the growing child.

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[1] Added to the list while this report was being edited.

(*e*) Good basic nutrition for all classes of people.
(*f*) Reasonably good conditions of employment.
(*g*) Good general sanitary surroundings in the home and family life.
(*h*) Adequate wage.

Several factors in the above list have a broad economic and sociologic significance and are in a certain sense beyond the specific province of the public health authorities, but the first four factors enumerated are the particular concern of the public health administrator.

Taking them up in due order, first of all is the problem of tuberculous infection through food, which for practical purposes means milk. Just how great a factor cow's milk is in the spread of human tuberculosis is as yet undetermined, but everywhere it is considered to be large. The two possible means of solving this phase of the tuberculosis problem are (1) an absolute eradication of tuberculosis from dairy herds, and (2) rendering all milk harmless from the standpoint of transmitting tuberculosis. The first is impracticable; the second is absolutely practicable through the process of pasteurization. Great steps forward have been taken in this direction throughout the Commonwealth in the last few years, but the complete realization of this ideal is still one of the direct lines of attack open to the public health administrator.

As for the second factor, the need of reports of disease is self-evident. As has been well said, no local, State or national department of health can adequately attack any disease problem without this fundamental. The reporting of tuberculosis in this State is still far from perfect. It is probably as well reported as in most other parts of the civilized world. Yet analysis of the various sources of information from which this Department obtains data in reference to tuberculosis shows that the Department's information in approximately 25 per cent. of the cases of which we have knowledge is obtained from sources other than the official reports of local boards of health. A great deal of necessary work still remains to be done in this field. The mere reporting of cases without intelligent analysis and comprehensive follow-up systems would be of practically no value, but with such a system and the co-operation of institutions, dispensary service and workers in school hygiene much valuable preventive work can be carried out both by preventing the known consumptive from infecting others, and by putting under careful supervision all other persons who are known to have been in close contact with consumptives, especially children. Therefore the extension of such follow-up work and dispensary service, and particularly of school hygiene, is a line of attack that deserves to be most thoroughly and continually carried out by all health officials.

From the standpoint of adequate institutional facilities the Commonwealth of Massachusetts is now well in the van among civilized States and countries. Certain phases of the institutional care of the tuberculous are as yet unsolved; for example, the control of the incorrigible consumptive and suitable institutions for the pre-tuberculous and for nonpulmonary forms of tuberculosis. But considering tuberculosis from the standpoint of an infectious disease, the open case of consumption is the logical point of attack, and with the completion of the building program now being inaugurated under the county tuberculosis hospital law, institutional facilities for consumption in this State will be practically complete.

The importance of hygienic supervision of the child from the standpoint of tuberculosis prevention has received recognition only in recent years. It is probable that in the enthusiasm that always is lavished on new views by their protagonists, some champions of the current views which seek to explain nearly all tuberculous processes as a result of childhood infection go entirely too far. Just so far as such teachings are seized upon as an excuse for neglecting any reasonable means to control the spread of tuberculous infection by adults, they are, in the light of our present knowledge, misleading and dangerous.

But the agitation of recent years certainly has proved beyond doubt that an initial milk tuberculous infection in childhood can be the focus around which a disastrous, virulent, adult reinfection or relighting of the original infection can spread; that infection in childhood is very common; and that proper hygiene during childhood can permanently arrest incipient infection to a degree that cannot be duplicated in adult infections.

All these facts indicate the great opportunities for child hygiene and school hygiene in preventing tuberculosis. These subjects are as yet scarcely developed in a practical administrative sense by the health and educational departments of this Commonwealth.

Here lies one of the greatest weapons of the attack against tuberculosis in the future.

These four groups of factors are the phases of the tuberculosis problem that practically concern the epidemiological and the public health administrator in general. By carrying out efforts along these lines in a poorly correlated and faltering manner in the past great progress has been made in staying the ravages of the disease. It is therefore at least not unreasonable to expect that patient and persistent efforts intelligently directed along these lines in the future will be rewarded by a still greater degree of success in the control of tuberculosis.

2. *Lobar Pneumonia.* — This disease ranks second among the preventable causes of death in this Commonwealth. That lobar pneu-

monia is an infectious disease no one disputes. Because it is an infectious disease it must be considered as theoretically controllable, but from a practical aspect nothing has been done toward efficient control of pneumonia until very recently. Even yet the circumstances under which the various strains and varieties of the pneumococcus cease to be merely harmless parasites and become extremely deadly germs within the human body are most imperfectly understood. Still less understood are the circumstances under which the virulent type of the pneumococcus is transmitted from individual to individual. Because of these facts it is the exception and not the rule to find lobar pneumonia included in the list of diseases required to be reported to health authorities.

In recent years, however, most promising work has been done, not so much along the line of prevention of the disease as in the direction of specific serum treatment for certain strains of the pneumococcus.

Furthermore, the work of General Gorgas at Panama and other observers in other parts of the world has demonstrated that, although we cannot point out as yet just what conditions influence the virulence of the organisms, or favor or hinder their passage from person to person, the observance of certain fundamental principles of mass sanitation and hygiene will affect materially the total incidence of pneumonia. For these reasons it would seem as if the time was now ripe for this Department to declare pneumonia reportable as a disease dangerous to the public health, and also to seek from the General Court funds for laboratory research along the lines of serum therapy; also it seems as if it would be wise for the Department to make a special effort to bring before the local boards of health and large employers of labor, in a simple, concise form, the importance of over-crowding, excessive fatigue, intemperance and improper housing conditions as factors affecting to a large degree the total prevalence and fatality of pneumonia among masses and groups of the population.

3. *Diphtheria.* — The diphtheria problem of the State presents some interesting features.

Diphtheria should be susceptible of control by public health methods. Its precise causation is accurately known. The bacilli can be promptly identified by laboratory methods without waiting for any long drawn out laboratory processes. The ease with which it can be detected furnishes a reliable guide to determine when danger of infection from the patient ceases. There is still a great popular respect for and dread of the disease, and in antitoxin the most reliable preventive and curative agent that the science of biologic therapy has yet produced is always at hand.

The State and local boards of health, through the State antitoxin laboratory and State and local diagnostic laboratories, furnish every scientific facility for detection, prevention and cure. Physicians apparently are very prompt, as a rule, to report diphtheria, and boards of health to vigorously quarantine. Yet the disease causes several hundred deaths in the State annually. The precise reason why this should be is still a little obscure. For the past year the District Health Officers have made a careful investigation of the exact circumstances surrounding each death reported in the past three years. The investigation has proceeded far enough to reveal the fact that the greatest cause of fatalities has been neglect of parents to call in a physician until the case was hopeless. Minor causes have been failure on the part of the physician to give a sufficient amount of antitoxin, or the waiting for a positive laboratory return before giving any antitoxin.

It is encouraging to note a pronounced decrease in diphtheria deaths for 1916 over 1915. Whether this is a mere coincidence, or due in a certain degree to the careful investigation of the District Health Officers and the accompanying amount of educative effect that such an investigation always brings, it is yet too early to determine.

Specific education of the medical profession relative to the need of sufficient and sufficiently early doses of antitoxin and of the danger of waiting for laboratory confirmation, the extension of school hygiene measures, and general education of parents are the lines of attack that are most promising. Such measures as the Schick reaction, early search for carriers, and toxin-antitoxin immunization in institutions for children are most valuable subsidiary measures that must be extended in the future.

4. *Scarlet Fever, Measles and Whooping Cough.* — Although these three diseases are very differently regarded by the general public, yet in their comparative immediate fatality and in their manner of transmission they present very similar problems. Scarlet fever is not as readily contagious as the other two, is relatively more fatal, and is held in much greater popular respect. Occasionally scarlet fever is transmitted by milk, but for practical purposes the general statement may be made that these three diseases are all essentially "direct contact" problems, and because of their age predominance essentially school hygiene problems. Our most hopeful lines of attack are the extension of school hygiene, broader education of parents, and, to a limited extent, specific vaccine therapy.

Owing to the fact that so many thousands of parents still consider measles and whooping cough as trivial ailments, the reporting of these diseases, while having distinctly improved in the past three years, is yet seriously defective. The correction of this condition is one of the immediate problems of the health administrator.

5. *Typhoid Fever.* — Typhoid fever in this State seems to be approaching practical extinction as a public health menace. This does not mean that any demonstrated safeguard can be omitted or the vigilance of public health authorities relaxed. It is most probable that there will be in some future years a slipping back. But it means, broadly speaking, that sanitary science and preventive medicine have won their fight against this particular disease.

Each year our water supplies are made safer, our milk supplies better safeguarded at their sources, and more milk itself safeguarded by pasteurization; outbreaks are detected sooner and carriers more promptly apprehended, with a result that in 1916 for the first time on record the total deaths have dropped to less than 200 in a population of nearly 4,000,000.

6. *Syphilis.* — In direct contrast with typhoid fever, public health control of syphilis has hardly begun. From the peculiar character of the disease it is futile under present conditions of public sentiment to attempt to isolate cases of syphilis.

This Department has inaugurated two practical measures, aimed at checking the ravages of the disease, — free Wassermann examinations and free distribution of salvarsan. The status of the latter measure is given in the report of the Food and Drug Division, but the former has been open to all public institutions, boards of health and physicians of the State for the past year and a half.

Institutions avail themselves very freely of the opportunities for Wassermann examinations, but intensive work is still necessary among members of the medical profession in general practice before the full benefits of this examination can be realized. Wider facilities for hospitalization of syphilitics are necessary, and beyond question other practical measures as yet untried will be evolved in the near future. Toward such measures the best thought and study of public health administrators must be directed.

V. The Diagnostic Laboratory.

The work of the diagnostic laboratory has continued along the same lines as in previous years. The increase in the amount of work the laboratory was called upon to do for the fiscal year, Dec. 1, 1915, to Nov. 30, 1916, has practically continued in the same proportion as in previous years. The increase amounts to 5,000 examinations, or 34 per cent.

The following table shows the total number of specimens examined per annum for the past seven years: —

1910,	6,458
1911,	7,814
1912,	7,854
1913,	10,701
1914,	11,924
1915,	17,229
1916,	22,061

The same difficulties of service noted in last year's report still exist. The quarters of the diagnostic laboratory are utterly inadequate for the amount of work done and the requirements necessary for laboratory facilities.

As can be noted from the report of the bacteriologist, the cost of examination per specimen has again been reduced; this in spite of the constant increase in the price of apparatus. This is due to the executive ability of the bacteriologist plus her willingness and that of her assistants to give overtime freely to the service of the State.

Several suggestions made by the bacteriologist in last year's report, designed to improve the usefulness of the laboratory, have not yet been put into effect because of lack of time, funds and laboratory facilities. The need of a branch laboratory in the western part of the State at Springfield is becoming more apparent each year. At the same time, it is probable that a carefully conducted campaign among the boards of health in that section of the State should result in utilizing the State laboratory at Boston to a greater extent than they do at the present time.

Among the greatest problems that confront the laboratory is that of giving extensive assistance to local boards of health when routine diphtheria examinations are desired for the purpose of detecting carriers. For this type of work speed is absolutely essential, and a large number of examinations must frequently be made to locate comparatively few individuals, perhaps two or three, in a school population of several hundred. A few such carriers often are responsible for the continuance of diphtheria cases in spite of the best efforts on the part of the local authorities in such respects as liberal use of antitoxin, prompt reporting and stringent and thorough quarantining of clinical cases. The utilization of the laboratory for the detection of typhoid carriers is being constantly increased. During the past year, although a slightly smaller number of typhoid culture examinations of blood, feces and urine was made than in the previous year, these cultures represent more individuals; that is, there were less repetitions, and the typhoid bacillus was isolated in 35 instances as against 23 for the previous year. The use of the laboratory frequently results in a rapid solution of a typhoid problem that in previous years would have continued until an extensive outbreak resulted. Its usefulness as a preventive measure is most apparent in milk-borne outbreaks. In one week during the past year 3 positive results were obtained in such outbreaks. In each instance this resulted in the source of infection being isolated, the milk supply being stopped and but few cases infected.

The number of examinations of sputum for the presence of tubercle bacillus represented only a very slight increase over that of last year. A special effort should be made by the Division during the coming year to encourage physicians to send in more specimens of sputum and to repeat sending specimens when the first reports are negative.

Future Problems.

Among the lines of work that offer the best prospects of usefulness in connection with the laboratory in the immediate future are the following: —

1. To endeavor to persuade more boards of health to authorize telephonic or telegraphic reports, at their expense, on positive diphtheria cultures.

2. To arrange a system of reciprocal reporting among all laboratories in the State doing diagnostic work in such a manner that boards of health, from whose jurisdiction specimens have been submitted by physicians for diagnosis to either State, municipal or private diagnostic laboratories, may have prompt and immediate knowledge of positive returns on such cases, and that this Department may receive more prompt information concerning diagnostic work done outside of the State laboratory. By this means definite knowledge of the existence of diseases dangerous to the public health could be brought to the attention of the boards of health having jurisdiction, which, under present conditions, would never be reported or would be reported with the loss of the time that would be invaluable from the standpoint of effective preventive measures being inaugurated.

A report of the bacteriologist may be found in the Appendix.

VI. THE WORK OF THE STATE DISTRICT HEALTH OFFICERS.

The work of the District Health Officers continues constantly to broaden in scope and fundamental importance. The past year furnished a most exacting test of the possibilities of the District Health

Officer system in epidemics. Demands both for diagnostic assistance and for advice as to the administrative control of poliomyelitis during the summer were so great as to leave the District Health Officers practically no time for other duties for a period of two and one-half months. While this had the natural effect of greatly interfering with many of their other routine duties, the advantages of such an organization were made manifest as never before.

The State health organizations of several neighboring States were completely swamped by the calls for assistance, and it was utterly impossible for them to put into effect any systematic, investigative procedures. In a few of the largest Massachusetts cities the local health administrations were so well organized that they did not need or request any such assistance. With these exceptions, the District Health Officers of this Department saw practically every case reported as poliomyelitis, in addition to a large number which were under suspicion and later proved not to be cases of the disease; obtained careful detailed epidemiological data on a very large percentage of them on the spot; and supervised the subsequent collecting of data on those cases which they were unable to obtain because of stress of circumstances in the midst of the epidemic. Of still greater importance, the District Health Officers' knowledge and experience proved a constant and gladly availed-of source of reliable advice and information for members of local boards of health. The result was that, with very few exceptions, unreasonably drastic regulations were conspicuous by their absence throughout the State during the epidemic.

No more valuable index of the beneficial results of the principle of full-time District Health Officers can be obtained than in the steady tendency manifested in the last few years of a decrease in the number of serious epidemics and an average decrease in the number of cases involved in the individual epidemics. This is particularly true in such diseases as typhoid fever, diphtheria and scarlet fever, where the means of control are reasonably well established.

Work of the District Health Officers with Reference to Communicable Diseases.

Reference has already been made to the nature of the work performed during the outbreak of poliomyelitis. In all of the other outbreaks of communicable diseases the District Health Officers, as a matter of course, have carried out the usual procedure of investigation and administrative advice to the local boards of health, in certain instances calling upon the epidemiologist for assistance on the individual features of the special outbreak when it was indicated that such assistance was desirable.

The usual procedure of investigating all cases reported on milk-producing farms immediately, when called to the attention of the Department, has been carried out throughout the year with gratifying results so far as secondary outbreaks from these diseases are concerned. The milk outbreaks reported during the year have been relatively few, both in number and in number of cases per outbreak. There can be no question that this policy of promptly investigating the circumstances of any cases reported from milk-producing farms must prevent many potential epidemics from ever occurring.

The work of the District Health Officers in certain individual diseases deserves some notice at this point.

Throughout the year the District Health Officers have carried on the policy inaugurated in 1915 of investigating in detail the circumstances surrounding each death from diphtheria. The complete reorganization of the manner of compiling death returns by the State Bureau of Vital Statistics has had an important bearing on the efficiency of these investigations, for by this means it is possible to determine where these deaths occur and have them investigated within a few months after their actual occurrence, instead of having to wait from a year to two years, as was previously the case.

It is too early as yet to draw conclusions in reference to the effect of these investigations, yet the fact is very striking that this year there has been a very pronounced drop in the number of diphtheria deaths compared with 1915 or 1914.

The tuberculosis dispensaries are considered to be largely the special charge of the District Health Officer in the respective districts. The establishment of the majority of them was accomplished under his oversight and with his carefully considered advice. The equipment and personnel were passed on by him, and he is in close touch with the methods employed in each.

Monthly conferences of the tuberculosis dispensary workers have been carried out through the greater part of the year. The District Health Officers have addressed these conferences at various times, and have in many other respects added greatly to their efficiency and usefulness.

General Administrative and Investigative Duties.

The District Health Officers have all carried on work in these lines effectively and persistently. In two additional districts organizations have been formed by the local health workers within the districts. Local boards of health have shown a greater tendency than ever before to call upon the District Health Officers for advice in a great variety of instances. The supervision of tuberculosis dispensaries has been carried on in a tactful and firm manner by the District Health Officers. The routine inspection of jails, reformatories and lock-ups has been carried out as usual, and the usual number of nuisances have been investigated and advice given upon request of the local boards of health.

For the first time an attempt was made this year to make an inspection of all kinds of hospitals and institutions caring for diseases dangerous to the public health, in accordance with the evident intention of section 35, chapter 75 of the Revised Laws, which provides that "the state inspectors of health shall annually make such examination of said hospitals, and of all other hospitals, sanitaria, asylums, homes, prisons and dispensaries, both public and private, caring for diseases dangerous to the public health, as in the opinion of the state board of health may be necessary, and report as to the condition and needs of such hospitals, sanitaria, asylums, homes, prisons and dispensaries, both public and private, caring for diseases dangerous to the public health, as in the opinion of the state board of health may be necessary, and report as to the condition and needs of such hospitals, sanitaria, asylums, homes, prisons and dispensaries, to those responsible for the management of the said institutions." A form of blank was devised for the purpose of giving a maximum amount of information with reference to the institutional care of diseases dangerous to the public health with a minimum amount of trouble for the authorities of such institutions and for the officials of this Department in making such inspections. It has been found impossible to visit all of the institutions that care for diseases "dangerous to the public health." All of the institutions designed exclusively for the care of tuberculosis and contagious diseases have been inspected, and as many of the general hospitals as time would permit.

The usual lectures in conjunction with the Division of Hygiene, 196 in all, have been given by the District Health Officers throughout the year.

VII. Miscellaneous and Special Work by the Division.

The director and the District Health Officers have delivered numerous addresses on various topics of a public nature before popular and professional audiences. At the direction of the Commissioner, the director of the Division attended the Annual Conference of State and Provincial Boards of Health of North America on May 15, 1916, at Washington, D. C.; and the director and two of the District Health Officers attended the Third Annual New England Conference on Tuberculosis on Oct. 12, 1916, at New Haven, Conn.

The director and the District Health Officers attended the meetings of the Massachusetts Association of Boards of Health and the Massachusetts Medical Society. One of the District Health Officers attended the meetings of the American Public Health Association in Cincinnati, as an official representative of the Department, and another one of the District Health Officers attended the same meeting as an unofficial representative of the Department on a leave of absence.

The director of the Division delivered an address before the Conference of Health Officers of Vermont upon the milk problem of Massachusetts as it affected the producers in Vermont.

The epidemiologist delivered a large number of addresses of a public health nature, and during the year made two or three brief trips outside the State for a conference with health authorities of other States on disease outbreaks in which the source was suspected to lie outside the Commonwealth.

During the height of the poliomyelitis outbreak, and when the greatest uncertainty prevailed as to restriction of travel, at the direction of the Commissioner, the director of the Division called a conference of the New England States. The boards of all the New England States were represented except Vermont and Connecticut. At the conference a uniform and simple type of travel certificate was agreed upon, and the agreement was made that there should be no restriction of travel locally between the States represented at the conference.

Several of the District Health Officers made surveys of certain towns within the Commonwealth which seemed to be promising as possible localities for carrying out the three-year community health experiment by the National Association for the Study and Prevention of Tuberculosis. Such surveys were made in the following towns: Andover, Canton, Framingham, Greenfield, Ipswich, Maynard, Norwood and Winchendon. The town of Framingham was finally chosen by the Committee of the National Tuberculosis Association, having the matter in charge, as being the most suitable community in the States under consideration for the carrying out of this experiment.

The most important special work by any of the Division's personnel during this year has been that of Dr. William W. Walcott of the South Midland District, in conjunction with the Special Commission on Social Insurance established by the 1916 General Court. Under the terms of this resolve the State Department of Health was directed to furnish such professional and technical advice as this commission should desire. As Dr. Walcott has been especially interested for many years in the problems of industrial hygiene, an arrangement was made whereby, for several months, neighboring District Health Officers took over a considerable portion of his routine duties, and finally, by arrangement with this commission, Dr. Walcott's entire services were given to them for investigative purposes during the last two months of the fiscal year.

This detail proved to be a splendid illustration of the flexibility of the District Health Officer system as at present organized. It would be far from the truth to say that the Department, through Dr. Walcott, was able to carry out this extensive detailed work without doing any damage to the routine work of the District Health Officers. There is always plenty of work of a most practical public health nature at all times for each District Health Officer within the limits of his own district. But, nevertheless, experience has demonstrated that for short periods of time work can be so adjusted by the co-operation of several of the District Health Officers that one of these officers can be detailed to some special piece of work of investigation without serious detriment to the efficiency of his work in his own district.

DIVISION OF BIOLOGIC LABORATORIES.

MILTON J. ROSENAU, M.D., *Director and Pathologist.*

REPORT OF THE DIVISION OF BIOLOGIC LABORATORIES.

The year was marked by considerable activity in both the amount and the nature of the work carried on at the Antitoxin and Vaccine Laboratory at Forest Hills and at the Wassermann Laboratory on Longwood Avenue, Boston.

Dr. Herbert R. Brown resigned his position as assistant director of the Antitoxin and Vaccine Laboratory on Sept. 1, 1916, and his place was taken by Dr. Rudolph Kohn, who was appointed on Aug. 1, 1916. The only other important change in personnel was the addition of an assistant in the Wassermann Laboratory to help in the increasing work undertaken by that service of the Division. Minor changes in technique and readjustments in the administration of both laboratories were made from time to time in order to improve methods, hasten reports or to effect economies.

During the year a request was made to the Secretary of the Treasury to have the Antitoxin and Vaccine Laboratory and its products licensed under the act of July 1, 1902, which provides for Federal supervision of biologic products that enter interstate traffic. Dr. G. W. McCoy, director of the Hygienic Laboratory of the Public Health Service, made the inspection on Oct. 6, 1916, as a preliminary step; and samples of all the products made and distributed by the laboratory were sent to Washington, where they are now being examined for purity and potency. Legally, it is not necessary to have a government license for the biologic products made and distributed by the State Department of Health, for these products do not enter interstate traffic, but this step was taken by the Commissioner of Health as an additional safeguard, as well as from the standpoint of example and comity.

Regarding new activities, perhaps the most important event in the fiscal year covered by this report was the enlargement of the work of the Wassermann Laboratory. On May 1, 1916, the laboratory examinations for the Bureau of Animal Industry were transferred to the Wassermann Laboratory. This new work consists in the main of diagnostic tests for contagious and infectious diseases of animals, many of which are transmissible to man. The tests in question require special technical skill and are chiefly as follows: a test for the recognition of glanders, known as the complement fixation test; and the examination of dogs to determine the absence or presence of rabies. In addition, the Wassermann Laboratory has made a number of miscellaneous analyses to determine whether certain animals are afflicted with anthrax, hemorrhagic septicæmia or other serious disease. Most of these diseases have a direct bearing upon human pathology, being transmissible to man. Glanders, for instance, occurs both as an acute and chronic affection in horses, and often causes large economic losses. The disease is often difficult to recognize, and unless detected, the infection spreads rapidly and may decimate stables. Persons who come in contact with glandered horses are apt to contract the disease, which is commonly known as farcy. The diagnosis of this serious infection is a public health problem of considerable magnitude, and its successful prevention rests almost entirely upon special diagnostic methods.

Rabies in dogs and other animals has been more or less prevalent in Massachusetts for several years. The disease in man is almost always caused by dog bites, though occasionally by the bites of other "mad" animals. The prevention of the disease in man depends primarily upon the suppression of the malady in dogs. It is often difficult to recognize this infection in dogs by its symptoms, and therefore the aid of the laboratory is necessary. Fortunately, we have precise tests by which we are enabled to determine whether a dog is rabid or not. These tests consist in looking for minute structures, known as Negri bodies, which are found only in the brain of rabid animals. These Negri bodies are so tiny that they can only be seen by the high powers of the microscope, and then only after appropriate methods of staining to make them readily visible. Pathologic alterations also occur in the nervous ganglia which are always examined. To supplement these tests, animal inoculations are always made with each specimen; but as the results of animal inoculations are not evident for several weeks, they are used only as confirmatory to the preliminary tests.

In all, 985 complement fixation tests for glanders and 47 examinations for rabid dogs were made during the period from May 1 to Nov. 30, 1916.

An allotment of $1,500 from the funds of the Bureau of Animal Industry, approved by legislative enactment May 1, was transferred to the State Department of Health for the purposes in question. This sum, which was estimated in advance, is found from experience to be insufficient for the required work.

The test for the recognition of syphilis is now in its second year, and this part of the work of the Division of Biologic Laboratories is receiving increasing recognition as its purposes and usefulness are becoming more generally understood. During the fiscal year covered by this report a total of 25,497 Wassermann tests were made for State institutions, hospitals and patients of practitioners through the District Health Officers and local boards of health. A clinic is held on Tuesday and Thursday at the Wassermann Laboratory, when persons may present themselves in order to have a small quantity of blood withdrawn from an arm vein for the purposes of the test. During the fiscal year 1,024 persons have visited the laboratory with this object in view.

At the Antitoxin and Vaccine Laboratory at Forest Hills the change in the administration was accomplished without greater inconvenience than that incident to such changes. A total of 174,435,000 immunity units of diphtheria antitoxin were distributed to citizens of the Commonwealth free of charge. Expressed in other words, over 500 quarts of this precious serum were given out for the prevention and cure of diphtheria.

Through improvements in the technique, a larger yield of antitoxic serum is obtained from the horses than heretofore. This has resulted in a marked economy, and has permitted the Division to meet the demands of the situation without asking for an increased appropriation. The horses have been carefully weighed and watched as to their general condition. This is an important factor from the standpoint of making a satisfactory antitoxin. The newer methods of concentrating diphtheria antitoxin are being studied, and the assistant director has made a visit to other laboratories in order to standardize and improve our own processes of production.

During the year four horses were immunized with 32 cultures of meningococci for the purpose of making antimeningitis serum, useful in the treatment of cerebrospinal meningitis. Of these four horses two responded actively so that we now have on hand a quantity of this serum sufficient perhaps to last one year. In all, 25.4 liters (26.9) quarts) were produced, and 21 liters (22.2 quarts) were distributed throughout the year in bottles of 15 cubic centimeters each, representing 1,695 bottles.

The care in the production of vaccine virus has been rewarded by a product of unusual potency and purity. Many special safeguards are practiced in making this product, and special tests have been devised to make assurance doubly sure. Every lot of vaccine virus is tested personally by Dr. Rosenau and again independently by Dr. Reagh. If these tests demonstrate that the vaccine virus is of good quality, primary vaccinations are then made by Dr. Kohn and the "takes" carefully noted. Potency tests of each lot of vaccine virus are also made upon calves. It will therefore be seen that unusual safeguards are thrown around each lot of vaccine virus before it is used. In all, 130,046 doses of vaccine virus were issued by the laboratory during the fiscal year ending Nov. 30, 1916. This is largely in excess of the amount previously given out during any one year. Despite this large demand we have a supply on hand sufficient to last approximately six months. An additional supply of vaccine virus will be propagated during the winter to carry us over the year, for it is not advisable to make this product during the hot summer term.

A few changes were made in making typhoid prophylactic. We now use the culture known as Rawling's strain, which has given such good results in the hands of the United States army. Furthermore, care is taken not to heat the suspension higher than 53° C. Trikresol 0.4 per cent. is used as a preservative. The package in which the virus is distributed has been simplified and cheapened. In all, 46,370 doses of typhoid prophylactic were issued during the year. Each dose represents 1 cubic centimeter of the suspension of dead typhoid bacilli.

Material for making the Schick test, useful in determining whether persons are susceptible or immune to diphtheria, was distributed, and other miscellaneous operations conducted during the fiscal year. Experiments were started to test the effects of the ultra-violet rays in purifying vaccine virus; experiments were made to determine the effect of diet upon the toxicity of diphtheria toxine; and in two instances the administering of typhoid prophylactic for a skin disease known as lupus erythematosus gave encouraging results.

Financial Exhibit.

The total appropriation for the manufacture and distribution of serums and vaccines for the fiscal year ending Nov. 30, 1916, was $22,500. Of this sum the following apportionment was estimated for each product: —

Product.	Amount.	Total Cost.	Cost.
Diphtheria antitoxin (units), . . .	174,435,000	$17,655	$0.10 per 1,000 units.
Antimeningitis serum (cubic centimeters),	25,425	1,100	$0.65 per 15 cubic centimeters.
Vaccine virus (tubes), ...	130,046	2,600	$0.02 per tube ($1/60$ cubic centimeter).
Typhoid prophylactic (cubic centimeters),	46,370	1,150	$0.025 per cubic centimeter.
	–	$22,405	– –

These figures include salaries, rent of laboratory and stables, all overhead charges, and new equipment; also cost of animals and their keep, and miscellaneous expenses, as well as distribution of the products, including the cost of packages, postage, expressage, etc.

The sum appropriated for the Wassermann Laboratory was $5,000 for the fiscal year. There were 25,497 Wassermann tests made, which makes a single test cost $0.1961. The principal items which make up this budget are salaries, guinea pigs and their keep, miscellaneous supplies, stationery and postage.

Attention is invited to the fact that there has been an increased demand upon the laboratories for its products, and that lately there has been a marked increase in the cost of practically all materials that enter into their manufacture and distribution. The amount of the appropriation remains the same, and it has therefore been necessary to practice strict economies in order to make both ends meet. Some of these economies have embarrassed the work, and it has only been through the devotion and loyalty of the staff that the burden of the financial situation has been successfully met. Many times it has been necessary to carry on the work with makeshifts and under handicaps. I here take pleasure in expressing my appreciation of the willingness and fine spirit that has been shown by the personnel of the Division of Biologic Laboratories.

The detailed reports of operations of the assistant directors will be found in the Appendix.

DIVISION OF HYGIENE.

LYMAN ASA JONES, M.D., *Director.*

REPORT OF THE DIVISION OF HYGIENE.

In August, 1916, Dr. Lyman Asa Jones, State District Health Officer for the Northeastern District, was appointed director of the Division of Hygiene to succeed Prof. Selskar M. Gunn, who had been in charge of the Division since its organization in 1915, Professor Gunn resigning to give his entire time to other duties.

Mr. Lester W. Feezer, assistant to the director, on half time, resigned soon after to take up public health work in the west.

Earlier in the year Miss Minnie H. P. Bridges, serving as temporary public health instructor, left the service owing to a ruling of the Civil Service Commission.

For a similar reason Miss May B. Dickinson, advanced to the position of assistant to the director, discontinued her work with the end of the year.

Mr. Edward H. Williams, draftsman, employed in the Engineering Division, was transferred to the Division of Hygiene for three-fifths of his time, which was given to the preparation of charts and diagrams and work in the field.

Late in the year Miss Genevieve R. Jules, formerly a Boston school nurse, was appointed as a public health instructor, to assist in infant mortality work and in the work connected with the health exhibit.

The work of the Division divides itself along certain lines, as follows: —

- Child hygiene: —
  - Infant mortality: —
    - Prenatal work.
    - Infant hygiene.
  - School hygiene: —
    - Efforts to improve standards and efficiency of medical supervision of schools.
- Hygiene of adult life: —
  - Efforts to diminish mortality from cancer and the wear and tear diseases.
- Educational work: —
  - Lecture service: —
    - Lantern slides.
    - Films.
  - Health exhibit.

Educational work — *Concluded.*
  Publications: —
    Monthly Bulletin.
    Special bulletins.
    Baby book.
    Press service.
Poliomyelitis after-care.

CHILD HYGIENE.

Infant Mortality.

Infant Mortality Statistics of the Commonwealth of Massachusetts.[1]

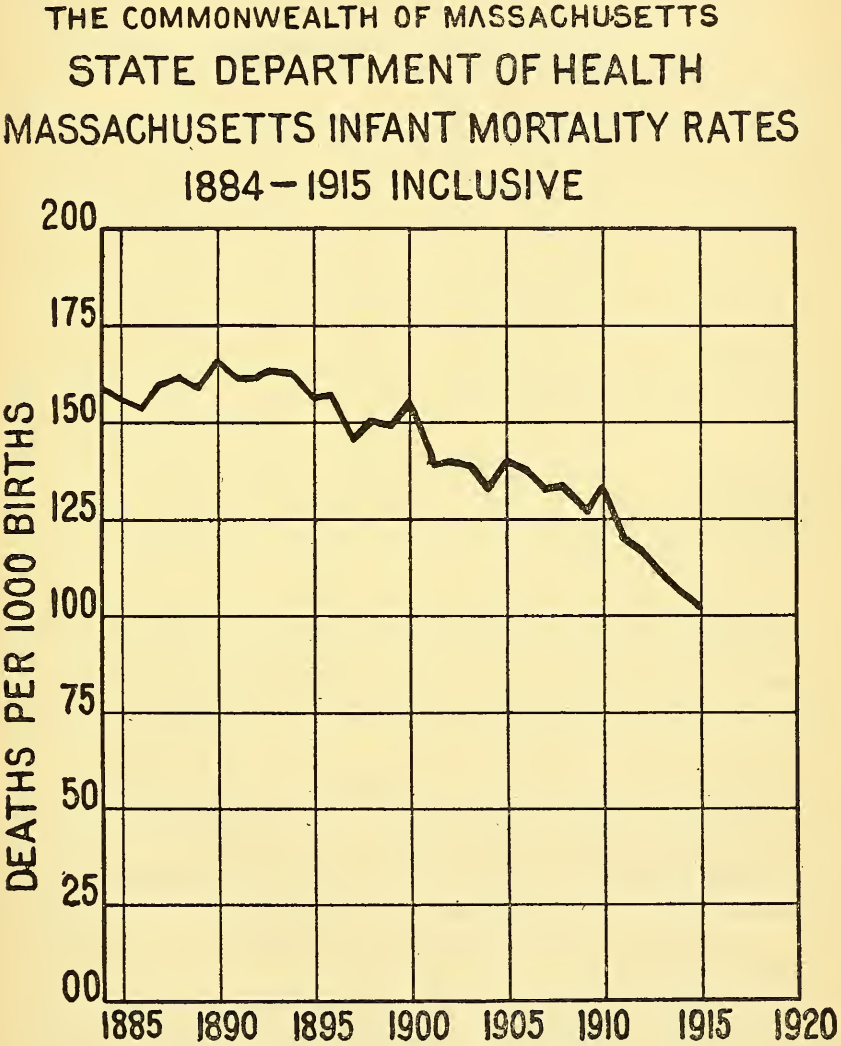
YEAR.	Total Births.	Deaths under One Year.	Infant Mortality Rate.
1910,	86,539	11,499	132.9
1911,	88,327	10,543	119.4
1912,	89,882	10,472	116.5
1913,	91,644	10,086	110.1
1914,	93,399	9,894	105.9
1915,	93,155	9,469	101.6

[1] Figures in this table taken from records of the Secretary of the Commonwealth.

A study of the figures for the years 1909 to 1914, inclusive, indicates that, in general, the rates in many of the cities are comparatively low, as is likewise the case in many of the smaller country towns, while rates are comparatively high in many of the moderate-sized towns, places varying in size from 1,500 to 10,000 population. Doubtless this may be explained in part as due to the preventive measures carried on by numerous public and private agencies in the larger cities, and to the naturally better surroundings in small country towns, while in the group above mentioned little or no preventive work has been undertaken.

Another feature disclosed by an examination of the infant mortality rates, as shown in the statistics gathered, is that about 40 per cent. of infant deaths occur during the first month of life. This means that in numerous instances the cause of infant deaths is to be sought in prenatal conditions, and that efforts to prevent such deaths cannot reach a maximum of efficiency without including prenatal work as an important part of preventive measures. Hence, for the coming year it is proposed to give this phase of the work special prominence by bringing the matter to the attention of public health nurses, district nurses and others interested as opportunity offers.

It is proposed, also, to undertake prenatal work along lines similar to those employed successfully in Kansas, where a series of monthly letters is sent to prospective mothers who apply for them, or to those whose names are supplied through nurses and health workers. Such a plan, well established, should show a favorable effect on the 40 per cent. of deaths which occur within the first month of life.



The following is a partial list of towns where the rates are high and where the number of deaths involved is such as to justify a special inquiry: —

Town.	Population.	Total Births.		Deaths under One Year.		Infant Mortality Rate.	
		1909-13.	1914.	1909-13.	1914.	1909-13.	1914.
Andover,	7,978	586	143	67	19	114	133
Bridgewater,	9,381	761	178	71	24	93	135
Danvers,	11,177	768	133	72	16	94	120
Dighton,	2,499	271	54	40	12	148	222
Freetown,	1,663	129	19	25	10	194	526
Granby,	828	61	5	6	3	98	600
Ludlow,	6,251	970	271	44	44	45	162
Montague,	7,925	1,134	244	118	40	104	164
Northborough,	1,797	140	24	9	6	64	250
Russell,	1,104	133	36	19	7	143	194
Seekonk,	2,767	271	63	52	14	192	222
Sutton,	2,829	360	69	39	15	108	217
West Bridgewater,	2,741	255	53	21	7	82	132
Wilmington,	2,330	212	60	17	16	80	267

The employment of such instructive health nurses, whether by State or municipal governments or by private agencies, is the next great step forward in public health work. Such workers will teach the people and will carry such instruction into the homes where it will be most effective.

At this point may properly be emphasized the sharp distinction between the instructive public health nurse and the visiting district nurse, so called. The former has official standing, and her work is primarily and exclusively educational; she goes into the home and the school to instruct, to inspect and to demonstrate, — to show people how to keep well and to avoid disease. No charge is made or accepted for her services.

The visiting nurse, supported by individuals, industrial establishments or private organizations, is engaged primarily in providing nursing care for those individuals or families where continuous services of a nurse are unnecessary or cannot be provided. Such services are given freely or paid for by a nominal or other fee such as the family can afford.

Of course the work of these two groups overlaps to a certain degree, in that the instructive nurse may actually bathe an infant or prepare its food, or disinfect typhoid stools, as a matter of demonstration in showing others how such things should be done, while the visiting nurse in doing many of these same things will be also teaching how to do them. This overlapping, however, does not interfere or make the distinction any the less valid.

Health nurses, under the supervision of the local board of health, and in co-operation with the attending physician, would do prenatal work, would do infant hygiene work, especially during the summer months, visiting homes where there were new-born infants, assisting at infant clinics, etc.; they would do the school work, visiting the schools with the school physician to take notes and assist, and would do the follow-up work in the homes, necessary to secure the correction of defects. This and other similar work would keep such a nurse busy, and would amply repay any expenditures necessary for its maintenance.

The child welfare exhibit, lectures on child welfare, moving-picture films and publications, in their relation to infant mortality, will be discussed in that portion of the report dealing with the educational work of the Division.

School Hygiene.

In 1906 a general law was enacted in Massachusetts requiring local school authorities to appoint and to maintain school physicians in their respective communities, except that in cities where the board of health was already maintaining or should thereafter maintain such medical inspection, supervision of the work should be in the hands of the Health Department.

The law provides that the examination of school children as to vision and hearing shall be carried out by the teachers, according to specifications prepared by the State Board of Health. In other respects the details as to methods and extent of work are left to local authorities, or left by them to the school physician. In consequence, to speak broadly, there are almost as many qualities of school inspection as there are communities concerned. In fact, the work, outside of some of the larger communities, varies practically according to the community and the individual physician concerned.

The following statements will help to make this plain. Save in a few localities where the physicians are on a civil service basis there are no special qualifications required for appointment as school physicians.

In the whole State, so far as known, there are but two or three full-time school physicians. In other places the school physician spends from one-half day each day during school sessions down to a single visit each term, or once during the school year, though he may be on call for emergencies at other times.

Records of examinations are rare.

The payment for services of school physicians is small, varying from nothing to $5, $10, $15, $25, $50, $100, $200, $300, $400 and upward per year, though in the great majority of cases the salary does not exceed $250 per year, while instances of a salary of $500 or over per year are rare.

Under these circumstances it is plain that there can be no standard of school medical inspection.

It is now becoming recognized that the work of medical supervision of schools is effective only as it secures improved conditions and correction of defects discovered. To this end school nurses are essential to do the follow-up work which physicians, especially the part-time physicians, cannot do.

But 44 cities and towns employ nurses, and in but 27 of these are the nurses employed on a full-time basis. Outside of Boston, which employs 38 nurses, but 7 cities employ a second or third full-time nurse. This showing in itself points to a high degree of inefficiency in much of this school work.

Medical inspection of schools was originally inaugurated in advanced communities with a view to controlling or preventing the spread of communicable diseases. This conception of the work has rapidly broadened, however, until it now includes all conditions which affect the physical, mental or moral development of the school child, or which hamper its progress or efficiency. Because of this broadened view the term of school hygiene is preferable to that of school inspection.

The present conception of this work comprehends the equipment of the school, its location, space for playgrounds and gardens, the building, its lighting, heating, ventilation, furnishing, cleanliness, sanitary conveniences, water supply, disposal of waste, fire protection, etc.

It comprises also the pupils, their general health, their hearing and vision, prevention of communicable diseases, the care of nutritional conditions, school lunches, a consideration of those conditions spoken of as pretubercular, provisions for open window and open-air rooms, etc.

From what has been stated it is evident that a vast field for development lies ahead if the possibilities for good are to be realized even in part.

So far as the State Department of Health is concerned efforts in this line must, of necessity, be carried on in co-operation with the State Board of Education, of which assurance has been given.

In the meantime the Division has in preparation a full report of the present status of school hygiene throughout the State, and is attempting through lectures, printed matter and in other ways, to spread knowledge of the value of such work and what it really comprises in the hope that the time will be hastened when its benefits may be fully realized.

Hygiene of Adult Life.

Efforts to diminish Mortality from Cancer and the Wear and Tear Diseases.

Cancer, diseases of the circulatory system and kidney lesions are increasing in this country, and in Massachusetts alone are responsible for approximately 15,000 deaths annually.

As to cancer the cause yet remains unknown, notwithstanding the many painstaking investigations being carried on, and until the cause is determined there would seem to be no likelihood of any rapid method for its prevention being devised.

There is a growing recognition that diseases of the circulatory system, and kidney diseases are, undoubtedly, favored by our manner of living, by the greatly increased tension of our daily life, by the character and quantity of our foods, while there is also a growing appreciation of the bearing of previous attacks of infectious diseases from a causative standpoint.

For the diminution of these diseases, too, there appears at the present time no short cut to reaching the desired goal. Instead, against this whole group of diseases which execute their maximum damage in the middle and later years of life must be waged a wide campaign of education which aims to make plain to each individual the importance of early attention to health matters, the necessity for seeking competent advice as to the nature and treatment of all tumors immediately upon discovery, when successful treatment is possible, which will make plain the wisdom of stated medical examinations in health, so that illness may be detected at its onset when preventive measures may be effective, or so that tendencies toward disease may be discovered and instructions given for overcoming them.

This work the Division is attempting to do by means of its lectures, some of them illustrated by charts or lantern slides, and through its publications or pamphlets furnished for distribution.

Educational Work.

The educational work of the Division is intimately associated with all of its other activities; indeed, from one point of view, the whole work of the Division is educational. While the work may be specifically directed toward the prevention of infant mortality, to the efforts to reduce the death rate from cancer or the circulatory disturbances of adult life, or to measures to raise the standard of school hygiene, its success is measured by the extent to which such knowledge is spread abroad and its presentation in a convincing manner so that the people, recognizing the value of preserving their health, will act in accord with such knowledge.

Lecture Service.

The lecture service, the inauguration of which was mentioned in the 1915 annual report, has been continued with success, the demand for health lectures constantly increasing.

The lantern slides arranged to illustrate the various lectures have been acceptable, but a year's experience has demonstrated rather a lack of flexibility in their use and the advisability of certain changes. For this reason, while retaining to an extent the grouping of the slides by subjects, as planned originally for certain lectures, there is in process of formation a slide library to which, at any time, additional slides may be added, such as slides to illustrate some new scene, table, local view or figures. Thus will result slides chosen to meet the immediate need of the subject with reference to its local application, and to fit the individual viewpoint of the speaker, permitting a more timely and forceful presentation of the subject with more individuality than when the speaker attempts to follow some arbitrarily selected and arranged series.

A copy of the card catalogue of the slide library will be furnished the State District Health Officers, and slides will be provided for individual lectures as may be selected by the speaker.

The lecture on quackery and the patent medicine evil has been temporarily withdrawn, not because the evil is unimportant, but because of the difficulty of presenting the subject without risk to the speaker. An effort is being made, however, to prepare a forceful presentation of the subject in such a manner as to avoid possible danger.

During the summer, lectures, accompanied with a set of small health charts, were given at field meetings of the grange in many parts of the State. These lectures elicited much interest, were well attended and will be repeated the coming year.

In October, through the co-operation of those in charge, a representative of the Division gave seven or eight lectures within a period of two days in a group of small towns, Ashfield, Cummington, Goshen and Plainfield. The attendance was good, much interest was shown, even by the school children, while at the same time there were involved a minimum of time, expense and travel on the part of the lecturer. Requests for similar groups of lectures are invited.

During Baby Week, which was observed in many places throughout the country, the Division provided 44 lectures in 11 communities. These lectures were given by eight representatives of the State Department of Health. Thirty-four of the lectures were illustrated with lantern slides or with slides and moving-picture films. At these lectures the aggregate attendance was 7,138, aside from one special talk given before 1,800 children.

In addition, sets of slides were used in 42 lectures given by persons not connected with the State Department of Health. The eight moving-picture films were shown, in the aggregate, more than forty times, while the Child Welfare Exhibit was divided into three sections and displayed in three of the large department stores in Boston.

Lectures were given during the year ended Nov. 30, 1916, as follows: —

MONTH.	Lectures.	Number Present.
1915.		
December,	45	6,343
1916.		
January,	73	11,517
February,	85	14,517
March,	107	17,795
April,	96	15,915
May,	59	13,503
June,	20	2,303
July,	21	2,205
August,	24	3,795
September,	24	2,710
October,	30	4,149
November,	38	3,275
Total,	622[1]	98,027

[1] Of these, 34 were given to school children only.

The ground covered in the lecture service is clearly indicated in the following summary of the many topics presented: —

Work of the State Department of Health, including explanations of what the Department is, of its relations to other departments and to local boards of health, and of the direct facilities and aids furnished local boards and physicians,	79
Child Hygiene, comprising topics relating to infant mortality and its prevention, including a consideration of prenatal work, infant hygiene, care of foods and information as to how to keep well,	191

School Hygiene, describing and explaining what it is, its possibilities and results,	48
Communicable Diseases, topics relating to various diseases dangerous to public health, their manner of spread, their prevention and control, including, particularly, tuberculosis,	169
Rural Hygiene, comprising topics intended to explain how health in country districts may be secured,	40
Diseases of Adult Life, especially relating to cancer and the wear and tear diseases,	25
Pure Food and Food Inspection, topics relating to the inspection and care of foods, including milk, slaughtering, cold storage, and referring also to the purity of drugs,	31
Public Health Nursing,	34
Quackery and Patent Medicine Evils,	5
	622

Lectures were given in the following communities during the fiscal year ended Nov. 30, 1916: —

Abington,	1	Cambridge,	36
Acton,	3	Canton,	3
Acushnet,	7	Carlisle,	1
Amesbury,	1	Chelsea,	2
Andover,	3	Chilmark,	1
Arlington,	1	Cohasset,	1
Ashburnham,	1	Colrain,	2
Ashfield,	2	Concord,	2
Athol,	4	Cummington,	3
Attleboro,	4	Dalton,	1
Auburn,	1	Dana,	3
Ayer,	3	Danvers,	2
Barnstable,	4	Dedham,	2
Bedford,	1	Deerfield,	1
Belchertown,	1	Dennis,	1
Bellingham,	2	Dighton,	1
Beverly,	14	Douglas,	2
Billerica,	6	East Bridgewater,	5
Blackstone,	1	Eastham,	1
Boston,	85	Easton,	5
Bourne,	1	Edgartown,	3
Boylston,	2	Enfield,	2
Braintree,	6	Everett,	3
Bridgewater,	6	Fairhaven,	8
Brockton,	6	Fall River,	10
Brookfield,	2	Falmouth,	1
Brookline,	2	Fitchburg,	9

Framingham,	4
Franklin,	1
Gardner,	7
Gay Head,	1
Gill,	1
Gloucester,	7
Goshen,	1
Grafton,	1
Greenfield,	4
Greenwich,	1
Groton,	1
Hamilton,	1
Hampden,	1
Hanover,	1
Harvard,	1
Harwich,	1
Haverhill,	7
Holden,	1
Holliston,	1
Holyoke,	7
Hull,	1
Ipswich,	6
Kingston,	3
Lawrence,	11
Lee,	1
Leicester,	3
Lenox,	1
Leominster,	2
Littleton,	1
Lowell,	14
Lynn,	6
Malden,	6
Manchester,	1
Mansfield,	2
Marion,	1
Marlborough,	1
Marshfield,	2
Medford,	1
Medway,	1
Melrose,	7
Mendon,	1
Methuen,	1
Middleborough,	2
Millbury,	1
Millis,	1
Milton,	1
Montague,	1
Monterey,	1
Nahant,	2
Natick,	5
Needham,	2
New Bedford,	6
New Braintree,	1
Newburyport,	1
Newton,	1
North Adams,	5
North Attleborough,	1
North Brookfield,	1
Northampton,	4
Norwell,	1
Norwood,	2
Oak Bluffs,	3
Orange,	2
Oxford,	1
Palmer,	2
Peabody,	5
Pembroke,	2
Pittsfield,	3
Plainfield,	2
Provincetown,	9
Quincy,	4
Randolph,	2
Rehoboth,	1
Revere,	1
Rochester,	1
Rockland,	11
Rowe,	1
Salem,	13
Saugus,	1
Scituate,	1
Sharon,	2
Shelburne,	3
Sherborn,	1
Shirley,	2
Somerville,	2
South Hadley,	2
Southborough,	1
Southbridge,	2
Springfield,	15
Sterling,	1
Stoughton,	3
Sturbridge,	2

Sunderland,	1
Sutton,	1
Swampscott,	1
Swansea,	1
Taunton,	3
Templeton,	1
Tisbury,	6
Topsfield,	1
Townsend,	1
Tyngsborough,	1
Wales,	1
Walpole,	2
Waltham,	2
Wareham,	1
Warren,	1
Wayland,	4
Wellesley,	3
West Brookfield,	1
West Newbury,	1
West Tisbury,	2
Westborough,	4
Westfield,	1
Westhampton,	2
Westminster,	1
Westport,	5
Westwood,	1
Weymouth,	2
Whately,	1
Whitman,	4
Wilmington,	1
Winchester,	1
Windsor,	1
Winthrop,	4
Woburn,	3
Worcester,	5
Worthington,	3
Wrentham,	3
	622

Moving-picture Films. — The moving-picture films have been much in demand for use in connection with various health weeks, with the health exhibit and independently, and in some of the public schools.

During the summer they were used for eight weeks at the park shows, — open-air exhibitions in the public parks in various portions of the city of Boston.

A new tuberculosis film has been purchased, "The Great Truth," which will shortly replace one of the present films which is much worn.

The moving-picture films were in use as follows: —

	Times.
"Fly Danger,"	64
"Toothache,"	57
"The Price of Thoughtlessness" (accident prevention),	56
"The Long *v.* the Short Haul" (infant welfare),	50
"Bringing it Home" (importance of infant welfare station),	43
"The Price of Human Lives" (tuberculosis),	41
"The Temple of Moloch" (tuberculosis),	28
"In His Father's Footsteps" (typhoid fever on the farm),	33
	372

There is no way of knowing the exact number of times the films were shown nor the number of persons who saw them, as in many instances no record was obtainable. The above figures represent the number of calls for the use of the films.

The moving-picture films were shown on special occasions, to unusually large audiences, as follows: —

Beverly, under the auspices of the Anti-Tuberculosis Society, "The Temple of Moloch" and "The Price of Human Lives," to 4,000 persons, and "Toothache," "Fly Danger" and "The Price of Thoughtlessness" to 1,850 persons.

Boston, at an agricultural fair, before audiences aggregating 600 persons, "The Long *v.* the Short Haul," "The Price of Human Lives," "The Temple of Moloch," "In His Father's Footsteps," "Bringing it Home" and "Fly Danger" were shown.

Attleboro, during a special health week, "Fly Danger" and "The Temple of Moloch" were seen by 6,000 persons; "Bringing it Home," seen by 5,000 persons; "Toothache," by 700 persons; and "The Long *v.* the Short Haul," "In His Father's Footsteps," "The Price of Human Lives" and "The Price of Thoughtlessness" seen by 900 persons.

Worcester, under the auspices of the District Nursing Association, the films "Toothache" and "The Price of Human Lives" were seen by an audience of 300 persons.

Health Exhibit.

The Child Welfare Exhibit has been used extensively during the past year. It consists of a series of about twenty panels each, calling attention to successive steps in the care of the infant and child; to the importance of having healthful parents; to the desirability of breast feeding; and, if bottle feeding is necessary, to the need for clean milk, properly cared for and prepared; to the value of fresh air, the daily bath and cleanliness in general; to the danger of using soothing syrups and patent medicines, etc.

Model but inexpensive outfits of baby's clothing are shown; likewise, models of simple and easily arranged ice boxes and pasteurizing utensils used in preparing and keeping the baby's milk; models of an untidy, ill-kept room, and, by way of contrast, a model of a clean, attractive room; also a model contrasting a polluted water supply and a properly protected one.

Some idea of the extent of the infant mortality problem is given by means of a flashing device, each flash of which signifies an infant's death.

At the exhibit health literature relating to child welfare is available for distribution. There are also in connection with the Department's exhibit additional displays made by local organizations, local hospitals, women's clubs, nursing associations, etc. Numerous health talks are also given during the week of the exhibit.

Representatives of the Department are present during the week to demonstrate the exhibit and to give information as requested.

For the coming year it is planned to show the exhibit at various places in the State, particularly in western Massachusetts, and later at as many of the county fairs as possible.

During the year the exhibit has been shown at the following places: Acushnet, Attleboro, Beverly, Boston, Brockton, Fairhaven, Fall River, Fitchburg, Gardner, Gloucester, Haverhill, Ipswich, Lawrence, Lowell, Malden, Melrose, Natick, New Bedford, Peabody, Provincetown, Rockland, Salem, Whitman and Winthrop.

During Gloucester Day in August, of the 40,000 persons in attendance, 5,000 visited the tent where the exhibit was displayed.

The real value of such exhibits is not easily determined in a brief space of time or in a concrete manner, and for this reason the following extract from a letter recently received is particularly valuable as pointing to the possible far-reaching effect of such exhibits, and would seem to amply justify increasing this branch of the work to even greater extent.

> It is encouraging to hear, once in a while, that our work is worth while, is it not? Let me tell you what your health exhibit meant to my little eight-year-old children. I have 49 second and third grade children, and, as the second grade did not go to the hall, I had to remain at school with them while the third grade went down with the older children.
>
> When they returned to school after their instructive visit I said, "We could not go to see the charts; tell us what you saw." They needed no other invitation, for they walked down the aisles with hands raised, so great was their enthusiasm.
>
> They told me that a fly walked over an old manure pile and then right into the house and over the baby. He had germs on his body and the baby died. The lady told them to swat the fly, and they are going to do it.
>
> They saw a baby sitting on the floor of a dirty room and flies were on the nipple of his bottle. This is what makes the baby sick.
>
> Another baby was so thin that he was almost dead because he did not have the right food. When he was given the right food he grew fat and well. One child said a mother was giving her own milk to the baby and that was the best food for him.
>
> They loved the baby who was "all dressed up and clean." This is what made him so fat and healthy, and he also had clean milk. To have a baby look like that he must sleep with the windows open.
>
> They saw a bathtub and a lovely doll baby. The baby should have a bath every day.
>
> The children were much impressed with the farm scene. They said the barn was built upon high land, and there was a well near by with nice, clean water for the cows. The house was built on lower land, and there was a well near this into which the drainage of the barn and sink ran. The people used this dirty water themselves.

They saw a house in which there was a lovely clean room and another dirty room. They are going to have a clean room.

You would be surprised to know that the picture showing factory conditions did not pass unnoticed. One little girl said she saw a girl who had nothing but a tin plate to eat out of, and then her employer made a nice clean lunch room. Another is going to tell her father of the danger of flying dust. She said her father gets dust all over him, even in his eyes.

I wish I had time to tell you the fund of information they brought me. I felt it might be encouraging for you to know that if little eight-year-old children could get so much from a short visit the knowledge older children gain cannot be measured.

Publications.

The work of the Division includes a general supervision of the publications of the Department to the extent, at least, of collecting manuscript, securing the approval for publication of the Supervisor of Administration, transmitting manuscript to the State printers, correcting proof, preparing indexes and other work connected therewith.

The Public Health Bulletin, the monthly publication of the Department, is prepared in this Division. At present 10,000 copies of the bulletin are distributed monthly to all physicians in the State, to local boards of health, clergymen, influential citizens, and to other State, municipal and national health authorities. In addition, advance copies are supplied to newspapers in the State.

From time to time there has been some discussion as to the character of the Monthly Bulletin. During the many years of its existence the Massachusetts Health Department has always maintained a high standard for its publications, both in matter and make-up, preferring to prepare publications which would convey information and appeal to those who were in a position to teach others. It should be the policy of the Department to continue its publications on the same plane, rather than to so modify them as to lose whatever of character and dignity may have attached to them in the past by making radical changes intended to catch the popular attention. If such a course is deemed necessary it would seem wiser to issue a second bulletin of a distinctly different character.

No special bulletins were published during the past year except a descriptive announcement of lecture service and moving-picture films.

During the year a health creed was printed for general distribution, especially among children, and an attractive health button was also used in school work.

The publication of "The Baby and You" will be continued. Sixty thousand copies were distributed during the past year, through local boards of health. A similar edition has been ordered for the coming year to meet the continuing demand. It is the intention that one of these booklets shall be sent to each home where there is a new-born baby.

The stereotyped plate press service has been used several times during the year on special occasions, as in connection with the Child Welfare Exhibit and the infantile paralysis outbreak.

Poliomyelitis After-care.

Among the problems arising from the unprecedented outbreak of infantile paralysis during the year is the subject of after-treatment, or management of the paralysis following the disease, so that there may result a minimum of permanent defect.

While this, strictly speaking, is a question of charities, yet from a larger viewpoint it is clearly within the language of the statute which enjoins the Department to "take cognizance of the interests of health and life among the citizens of the commonwealth."

To meet the emergency the Governor and Council granted the Department the sum of $5,000 from the contingent fund. Arrangements were then made to carry on clinics for the after-care of these cases in conjunction with the Harvard Infantile Paralysis Commission, the commission acting as agents of the Department.

Clinics have been established at the Children's Hospital in Boston, and plans have been made for holding similar clinics at places outside of Boston at such points as may be decided upon after conference with the State District Health Officers. The work is being conducted along lines similar to work that was done in Vermont last year and that being carried on in New York and other places at the present time.

Such a plan makes it possible for all who desire to secure expert examination and advice. The family physician is consulted in all cases, and to him are given personally or by correspondence the results of examination and suggestions as to treatment. Skilled nurses are provided to follow the patients to their homes and to assist parents in acquiring the technique of carrying out the prescribed exercises, if their services are desired.

The work in hand should eventually lead to a correction of defects in many cases, and to a lessening of permanent defect in other cases and corresponding increase in future efficiency, thereby contributing to the future health and happiness of those afflicted.

REPORT OF THE BOARD OF STATE EXAMINERS OF PLUMBERS.

JAMES C. COFFEY, *Chairman.*

REPORT OF THE STATE EXAMINERS OF PLUMBERS.

Information concerning Examinations for Plumbers, showing the Place and Date of Examination and Number examined, together with the Results of the Examination, etc.

EXAMINATIONS.	Examined.	Passed.	Refused.
Boston, Dec. 4, 1915,	102	21	81
Lowell, Dec. 18, 1915,	34	11	23
Boston, Jan. 1, 1916,	82	26	56
Pittsfield, Jan. 15, 1916,	27	8	19
Boston, Feb. 5, 1916,	101	32	69
Springfield, Feb. 19, 1916,	56	15	41
Boston, Mar. 4, 1916,	95	24	71
Fall River, Mar. 18, 1916,	46	12	34
Boston, April 1, 1916,	96	21	75
Worcester, April 15, 1916,	32	4	28
Boston, May 6, 1916,	92	11	81
Lowell, May 20, 1916,	46	2	44
Boston, June 3, 1916,	99	16	83
Pittsfield, June 17, 1916,	40	12	28
Boston, July 1, 1916,	103	16	87
Boston, Sept. 2, 1916,	100	2	98
Springfield, Sept. 16, 1916,	40	1	39
Boston, Oct. 7, 1916,	95	4	91
Fall River, Oct. 21, 1916,	39	3	36
Boston, Nov. 4, 1916,	68	7	61
Worcester, Nov. 18, 1916,	38	9	29
Totals,	1,431	257	1,174

	Masters.	Journeymen.	Total.
Licenses granted on account of examination Dec. 1, 1915, to Dec. 1, 1916.	48	209	257
Probationary licenses issued during the year,	–	–	16

Registrations.	Masters.	Journeymen.
December, 1915,	5	21
January, 1916,	6	48
February, 1916,	10	41
March, 1916,	7	27
April, 1916,	8	24
May, 1916,	1	19
June, 1916,	6	16
July, 1916,	3	28
August, 1916,	1	1
September, 1916,	1	2
October, 1916,	2	4
November, 1916,	2	5
Totals,	52	236

Meetings,	64	Examinations,	21

Fees received.	Paid to the Treasurer of the Commonwealth.
1,428 examination fees, at $0.50,	$714 00
3 examination fees held from May, 1916, at $0.50,	1 50
52 master plumber licenses issued, at $2,	104 00
236 journeyman plumber licenses issued, at $0.50,	118 00
1,740 master plumber renewals issued, at $0.50,	870 00
4,027 journeyman plumber renewals issued, at $0.50,	2,023 50
61 back fees received, at $0.50,	30 50
	$3,861 50

For carrying out the Provisions of the Act relative to the Examination of Plumbers.

Salary of clerk,	$2,000 00
Wages, second and third examiners,	535 00
Traveling,	429 12
Express,	34 01
Printing,	341 69
Postage,	168 50
Books and stationery,	32 00
Clerical services,	1,129 35
Cleaning,	24 75
Office supplies,	4 60
Telephone and lighting,	38 95
Typewriter and repairs,	84 88
Labor and materials,	40 14
Miscellaneous,	4 75
Total,	$4,867 74

Summary of Registrations.

	Masters.	Journeymen.
Certificate holders,	488	486
Licenses, year ending May 1, 1916,	1,751	2,741
Totals,	2,239	3,227

Deceased Plumbers (reported to Examiners).

Masters,	26	Journeymen,	12

JAMES C. COFFEY,
CHAS. R. FELTON,
DAVID CRAIG,
Clerk.

APPENDIX.

Legislative Reports.

LEGISLATIVE REPORTS.

WATER SUPPLY AND SEWERAGE AND PROTECTION OF INLAND WATERS.

The State Department of Health presents herewith a report of its doings for the year ending Nov. 30, 1916, under the provisions of laws relative to the oversight and care of inland waters, including advice to cities, towns and others in regard to water supply, drainage, sewerage and questions relating thereto.

The Department received during the year 154 applications, of which 37 were in relation to public water supplies, 60 to wells and springs, 8 to sources of ice supply, 25 to sewerage, drainage and sewage disposal, 5 to the pollution of streams, and 19 to miscellaneous matters.

WATER SUPPLIES.

A public water supply was introduced during the year in the town of Cummington, the works having been practically completed at the end of 1915.

Water works construction in 1916 has been extremely limited, less work of this kind having been done than for many years, — a condition caused chiefly by the high cost of such work and the difficulty of obtaining the necessary materials.

The number of cities and towns was increased in 1916 by the establishment of the new town of Millville, so that the State now contains 354 cities and towns. Of these, 212, having an aggregate population in 1915 of 3,529,429, are provided with public water supplies. The towns not yet provided with public water supplies contained by the census of 1915 an aggregate population of 163,881. Of these towns, those contained in the following list had by the census of 1915 a population in excess of 2,000.

Tewksbury,	5,265	Sutton,	2,829
Warren,	4,268	Seekonk,	2,767
Templeton,	4,081	Bourne,	2,672
Somerset,	3,377	Hanover,	2,666
Auburn,	3,281	Swansea,	2,558
Westport,	3,262	Wilbraham,	2,521

Dighton,	2,499	Harwich,	2,179
Acushnet,	2,387	Belchertown,	2,062
Wilmington,	2,330	Georgetown,	2,058
Rehoboth,	2,228	Upton,	2,036
Charlton,	2,213		

In practically all of the above-named towns public water supplies are greatly needed, since the wells are in many cases badly polluted and a serious danger to the public health. No action has yet been taken toward the introduction of a water supply in the town of Rowley, in which typhoid fever has been excessively prevalent for many years. The wells in this town, which were very thoroughly examined last year, have been found to be very seriously polluted, and there is no practicable plan of securing good drinking water in this village until a public supply from a suitable source has been provided.

One of the hindrances to the introduction of public water supplies, due to the requirement for bond payments, was removed by the Legislature of 1916. Nevertheless, owing to the causes already indicated, — the high cost of work and the difficulty of obtaining materials, — very little water works construction has been undertaken during the year.

A public water supply of good quality is the most important agent in the protection of the public health in thickly populated communities, and such supplies should be introduced at the earliest practicable time, especially in the larger communities which have not yet provided themselves with such works.

Rainfall and Flow of Streams.

The total rainfall in Massachusetts for 1916, judging from the observations on the watershed of the Sudbury River, was about 42 inches or about 2 inches below the normal. The greatest rainfall occurred in the months of February, June and July, when the amounts were greatly in excess of the normal, and the least in the months of January, August, October and November, when the rainfall was much less than the normal, making the thirteenth consecutive year of less than normal rainfall in the period of forty-three years covered by these records. While the rainfall for the year was much less than the normal, its distribution was such that the flow of streams in each of the months from January to July, inclusive, judging from that of the Nashua River, was greater than the normal, and the average flow for this period was greater than has occurred in that period in any year since observations of the flow of the Nashua River were begun twenty years ago. During the month of August the flow fell to less than normal and this continued until the end of the year.

As a result of this distribution of the rainfall, practically all of the water supply reservoirs of the State were filled to overflowing in the early part of the spring and were kept practically full until midsummer, so that, notwithstanding the dry weather in the latter part of the year, little or no inconvenience was experienced anywhere from lack of water.

Examination of Water Supplies.

During the past year most of the sources of public water supplies have been inspected by the Department and samples of their waters have been analyzed.

Of the 212 cities and towns having public water supplies at the end of 1916, 72 are supplied wholly from lakes and ponds or artificial storage reservoirs of large capacity in proportion to the yield of their watersheds, 35 wholly from small streams or from reservoirs of limited capacity, and 5 from streams after filtration, making a total of 112 municipalities supplied wholly from surface sources, a little over half the total. Of the remaining municipalities, 74 cities and towns are supplied wholly from springs, wells and other ground water sources, and 18 are supplied partly with ground water and partly from ponds or streams. The remaining municipalities, 8 in number, are supplied mainly with ground water supplemented with surface water filtered into the ground water source. While the number of municipalities supplied from surface sources is not greatly in excess of the number supplied with ground water, the aggregate population of the municipalities supplied from ponds and reservoirs alone greatly exceeds that of all others. This comparison is shown in the following table: —

	Number of Cities and Towns.	Population, 1915.
Supplied wholly from lakes, ponds and storage reservoirs of large capacity in proportion to the yield of their watersheds.	72	2,404,728
Supplied wholly from small streams or reservoirs of limited storage, .	35	222,612
Supplied with filtered river waters, ...	5	209,507
Supplied wholly with ground water, ...	74	521,824
Supplied partly with ground water and partly with surface water from streams and ponds.	18	107,261
Supplied mainly with ground water but supplemented with filtered surface water.	8	63,487
	212	3,529,429

There are twenty-six filters of various kinds in use in connection with the water supplies of the State. Two of these are large modern covered filters used for the filtration of river waters, and four are used in connection with ground water supplies for the removal of iron or manganese from the water. Those remaining range from a sand filter built of masonry and underdrained, but without a cover, to a natural sand bed without underdrainage to which surface water is supplied to increase the yield of a ground water supply in its neighborhood. Mechanical filters are in use in four towns, in two cases for the filtration of ground waters containing iron, and in two for surface waters. Several additional filters are used to filter the water of streams entering reservoirs and are constructed and used after the manner of sewage filters.

The total number of sources used during the past year by cities, towns, water companies and fire districts has been somewhat more than 300, and many of these sources have important tributaries. All of the sources of water supply have been examined during the year and samples of their waters have been analyzed. A considerable number of bacterial analyses has also been made in connection with these examinations.

Sanitary Protection of Public Water Supplies.

The shores of the great ponds of the State are attractive places of residence, especially during the warmer part of the year, and such localities are increasingly used for that purpose. When a pond or lake is used as a public water supply, the use of its shores as a place of residence for a considerable population involves danger to the purity of the water, which becomes more serious as the population increases. The best — and in fact the only — practicable plan of effectually protecting such water supplies is for the municipality using the pond to acquire control of its shores and prevent their occupation for dwellings or other uses which might affect injuriously the quality of the water. The cities and towns supplied from artificial reservoirs commonly acquire control of the shores of such basins at the time the reservoir is constructed, and many cities and towns taking water from great ponds have already acquired the control of the shores of those sources. The effective protection of the water supplies taken from great ponds does not ordinarily involve any great expense if undertaken in season, but the rapid growth of population in the neighborhood of lakes and ponds generally is a clear indication that, if water supplies from such sources are to be adequately protected from danger of pollution in the future at a minimum cost, their shores must be acquired without loss of time. While many, if not most, of the municipalities owning or using such sources have already secured a large part or all of the lands about them or are acquiring such lands rapidly at the present time, there are a few cases in which such measures have been delayed until the problem has become a serious one. A notable case of this is Great Sandy Pond, a source of water supply for the towns of Abington and Rockland, where a large number of cottages has been constructed about the shore of the pond, which has become a resort for considerable numbers of people in the summer season, a condition which is a constant and growing menace to the purity of the water and to the health of the population to which it is supplied.

It is of course practicable to make polluted waters reasonably safe by proper filtration, but it is far better to protect the purity of a water supply than to allow it to become polluted and rely upon artificial methods for the removal of the objectionable effects of pollution. At Wakefield, where the pond from which the supply is drawn is located close to the populated portion of the town and its watershed has already become quite populous, the water is treated with chlorine with a view to removing the injurious effects of pollution, a method of protection not always to be relied upon.

In order to enable cities, towns and fire districts to take land for the protection of their sources of water supply, an act was passed by the Legislature in 1908, chapter 499, granting such powers as are necessary for this purpose which the various authorities may use if they have no adequate authority for taking land for that purpose in their original charters. By chapter 135 of the Acts of the year 1911, the same authority was extended to water supply districts.

While the ownership of lands about them is usually essential for the adequate protection of the water supplies taken from ponds and reservoirs, it is also essential that such sources shall be guarded from practices which are injurious to their use as sources of public water supply. The statutes prohibit bathing in sources used for public water supply and forbid the use of such sources for other purposes. Furthermore, in order to make these provisions of law more effective, authority has been given the State Department of Health to make rules and regulations for the sanitary protection of all such waters as are used as sources of water supply. Many of the cities and towns using surface sources have petitioned for such rules, and they have been made by the Department in all cases where their enforcement has been deemed practicable. The application of these rules is sometimes a source of complaint, especially where boating, bathing, fishing, skating, horse racing, etc., are prohibited, but there is no question that such use of ponds and reservoirs is utterly incompatible with the maintenance of these waters in a condition in which they will at all times be safe for drinking. Of all public services, an uncontaminated water supply is the most important agent in the protection of the health and comfort of the inhabitants of a city or town, and the pleasures of a few in any community cannot be given weight as against the well-being of all.

The question of ice cutting is also an important one in connection with ponds and reservoirs used as sources of water supply. It is sometimes urged that such use is a necessity on account of the lack of other suitable sources of ice supply in the neighborhood of the city or town, or that such use was the practice long before the pond was used as a public water supply. In most cases the plea that other suitable sources are not available is of little merit because, on account of the nature and the manner of its formation, pure ice may be obtained from many sources which would not be fit for use as water supplies. The freezing of ice is a process of crystallization in which the impurities in the water are excluded, and water from clear ice is practically as pure as distilled water. Snow ice and ice formed by flooding a pond after freezing partake of the impurities in the water, but clear ice on ponds of reasonable depth is commonly of good quality, except as to matters that may have been floating upon the surface of the water and become entangled in the ice. Any danger from such causes can be removed by shaving off an inch or thereabouts from the top of the cake. Considering all of the circumstances, it is not necessary to use public water supplies as sources of ice supply for the sake of obtaining ice which will be safe for domestic use. On the other hand, the introduction of considerable numbers of men upon the ice of ponds and reservoirs is a menace to the purity of the water, which has become a very serious one in some cases. The rules and regulations adopted by the Department for the sanitary protection of water supplies generally prohibit the cutting of ice on ponds used directly as sources of public water supply, unless under permit, but it has been the custom of local authorities to grant permits for ice cutting, usually in cases where such use had been a practice for a long time before the regulations were established. In one such case — at North Watuppa Pond in Fall River — examinations of the water while ice cutting was in progress having shown that the process resulted in the serious pollution of the water and was likely to cause sickness among those to whom the water was supplied for drinking, the Department early in the year rescinded the authority to issue permits for ice cutting on that pond, and the question of the rights of the various parties concerned is now being determined by litigation.

Water Supply of the City of Lawrence.

During the winter of 1915–16 much difficulty was experienced in operating the filters of the water supply of the city of Lawrence at a sufficient rate to secure an adequate quantity of water for the requirements of the city, and during that period the filters were greatly overworked and their efficiency became less satisfactory than usual. Early in the summer work was begun on the reconstruction of a portion of the old city filter for the purpose of enlarging the yield of the filtration works, but this work has been carried on very slowly and has not been completed up to the present time. In consequence, the capacity of the filters has been temporarily materially reduced, and it will not be practicable during the present winter to secure an adequate supply of water by filtration from the Merrimack River. For the purpose of preventing a shortage of water, connections have been made by the city with the works of the adjacent towns of Andover and North Andover, and if the consumption of water in Lawrence is held within reasonable limits it will probably be practicable to secure a sufficient supply for the city in this way during the present winter. It is very important that the construction of additional filtration works at Lawrence should be pushed to completion as rapidly as practicable in order to avoid further danger of a shortage of water supply or the necessity of introducing unpurified or insufficiently purified river water into the water supply system of the city.

Salem and Beverly Water Supply.

The works for introducing the water of the Ipswich River to increase the water supply of Salem and Beverly were completed in the early part of the year ready for use the coming winter.

There has been a marked increase in the consumption of water from the sources of these cities, and it is becoming obvious that additional storage or further provision for taking water from the Ipswich River will become necessary at no distant time. The question as to whether the summer surplus flow of the Ipswich River can be used for the supply of these cities without detriment to other interests has been raised.

Under the circumstances, an investigation of this question will undoubtedly be necessary, and it is desirable, in the opinion of the Department, that it be undertaken at the earliest practicable time. In connection with this investigation it would also be advisable to consider whether any advantage would result to the different towns which may under present legislation take water from the Ipswich River if they should be given authority to combine the works for taking water therefrom. The Department recommends that a small appropriation be provided for this purpose in the present year.

DIVERSION OF FUNDS DERIVED FROM THE SALE OF WATER FOR OTHER MUNICIPAL PURPOSES TO THE INJURY OF THE SERVICE.

It has become the practice in some of the cities and towns in which there is an excess of income over expenditures in the water department to use the surplus income, or a portion of it, for the general expenses of the municipality. As the practice appears to be a growing one and has begun to affect unfavorably the protection and necessary development of water supply systems in some cases, as well as their proper maintenance and renewal, it seems desirable to call attention to the need of regulation of this practice. Several years ago, in one of the cities in which this custom had been followed, it became necessary to renew a portion of the works which had deteriorated and which could have been maintained in proper condition or restored thereto had the water works income been used for that purpose; but as the practice of using a portion of the water works income for the general expenses of the city had been followed for some time it was found that, if this income should be diverted to its proper purpose, an increase of taxation would be necessary. Under these circumstances it was deemed essential to borrow money for the renewal of the water works while the surplus income therefrom was being used for the general expenses of the city, — an indirect method of borrowing to meet general municipal expenses. Whether the use of surplus water income for the general expenses of a city or town is proper or not, such use is certainly objectionable when the proper maintenance and operation, renewal, protection or extension of the works are neglected, and it is very desirable that the use of such surplus funds be so regulated that the needs of the water works system shall be cared for before any of the money is diverted for other purposes.

WATER SUPPLY OF NEW LENOX.

Under the provisions of chapter 580 of the Acts of the year 1911, the city of Pittsfield is authorized to supply water for domestic purposes in the portion of Lenox known as New Lenox. The portion of the act referred to is as follows: —

SECTION 3. The city of Pittsfield is hereby authorized to supply water for domestic purposes, and for the extinguishment of fires, to that part of the town of Lenox called New Lenox which is within two miles of the northeast corner of the said town, on such terms and conditions as may be mutually agreed upon by said city and the town of Lenox. In case they cannot agree the state board of health may determine the terms and conditions.

The portion of Lenox described in the above act is greatly in need of a public water supply, and the Department is informed that the city of Pittsfield is prepared to supply water on terms which have been accepted by the town of Lenox at a town meeting, but that the selectmen of Lenox desire to avoid entering into an agreement in the matter fearing that the town will thereby be drawn into the water business and involved in some of the expenses of the water supply of the city of Pittsfield. There does not appear to have been any disagreement as to the terms and conditions, so that this Department appears to have no power in the matter under the act.

Since it appears that the city of Pittsfield is willing to supply the water in the district mentioned and that the town of Lenox is willing that the city of Pittsfield should so supply the water under the terms proposed, the Department recommends that legislation be provided which will definitely authorize the city of Pittsfield to supply water in the portion of the town of Lenox described in the above quoted act on the terms which appear to have been already agreed to by the city of Pittsfield and the town of Lenox, and thus do away with any objections that may exist to the proposed arrangement to supply water to the portion of Lenox under consideration which is very greatly in need of a water supply system.

Examination of Sewer Outlets discharging into the Sea.

All the sewer outlets discharging into the sea or tidal waters have been examined as usual during the year and no notable changes have been found in any case.

A new outlet is under construction at Deer Island which, when completed, will convey the sewage to deep water off the end of Deer Island which can be reached within a short distance of the present outlet. There has been no material change in the conditions about any of the other main sewer outlets in Boston Harbor from those described in the previous report.

At the Swampscott and New Bedford outlets the conditions have been found satisfactory as usual.

The new outlet at Manchester is located off the mouth of the harbor, and an examination during the summer showed that conditions about it are unobjectionable.

No change has taken place in the system of sewage disposal at Fall River during the past year, and further plans for the improvement of the Quequechan River, to abate the nuisance in that stream, are under consideration.

The city of Beverly and the town of Danvers can probably dispose of their sewage more satisfactorily by joint works at some point in Salem Harbor than by any other plan. Beverly has recently taken steps toward further consideration of this most important matter.

The sewer outlet at Salem, used by the cities of Salem and Peabody, discharges near Great Haste Island in Salem Harbor approximately at the surface of the sea at high tide, and the sewage spreads at times over a considerable area. This outlet could be greatly improved if it were extended to deep water, which can be reached a short distance farther from the city than its present location. The new outlet should be determined upon in connection with the consideration of a suitable outlet for the sewage of Beverly and Danvers.

No change has been made in the system of sewage disposal of the city of Lynn, and the sewage continues to discharge near the harbor front of the city, where it creates a most serious nuisance. A careful study to determine the best practicable method of disposing of the sewage of the city of Lynn was made in 1915 by this Department acting as a joint board with the municipal council of the city of Lynn, and a report with plans was presented to the Legislature of 1916 and printed as Senate Document No. 450 of the session of 1916. The report was presented late in the session and was referred to the next general court. It is advisable, in the opinion of the Department, that this important matter be considered at the earliest practicable time in order that action may be taken without unnecessary delay to remove this very objectionable nuisance.

Plans for a proposed temporary outlet into the sea for the sewage of a portion of the town of Hull, approved by this Department in 1914, were subsequently rejected, and the objectionable conditions affecting the public health at Hampton Head and Sagamore Hill were especially noticeable during the summer of the past year. It is very desirable that some provision be made for the disposal of the sewage of these thickly populated and rapidly growing sections of this town.

Sewage-disposal Systems.

The following is a list of the principal sewage-disposal works now in operation in the State: —

Amherst.
Andover.
Attleboro.
Billerica.
Brockton.
Clinton.
Concord.
Easthampton.
Fitchburg.
Framingham.
Franklin.
Gardner.
Hopedale.
Hudson.
Leicester.
Lenox.
Longmeadow.
Marion.
Marlborough.
Maynard.
Medfield.
Milford.
Natick.
North Attleborough.
Northbridge.
North Brookfield.
Norwood.
Pittsfield.
Southbridge.
Spencer.
Stockbridge.
Westborough.
Worcester.

The town of Amherst has recently constructed a sewer to the Connecticut River which removes a large part of the sewage formerly discharged at the filtration works, and the latter are now adequate for the treatment of the remainder of the sewage.

At Clinton, where a considerable quantity of wool-scouring waste is discharged into the sewers, there has been a material increase in the quantity of sewage discharged at the works during the past year. The filters have been found to be adequate to care for all of the sewage thus far discharged upon them.

There has also been a material increase in the quantity of sewage discharged at many of the other filter beds, especially at Andover, Lenox, Natick, Northbridge and Stockbridge.

The disposal works at Natick evidently require enlargement besides an improvement of the underdrainage of most of the existing filters, and this matter has been brought to the attention of the town authorities. It is probable, also, that further additions will be required to the filter beds at Andover, Northbridge and Stockbridge in the near future.

At Lenox the sewage continues to overflow into the Housatonic River, and a material extension to the filter beds is necessary at this works.

At Gardner more efficient results could be obtained with a better system of distribution of the sewage, while at Spencer the sewage is at times allowed to overflow into the river, though the filter beds are adequate to care for all of the sewage; and a similar condition is found at Southbridge, where the sewage is at times discharged into the Quinebaug River.

Manufacturing wastes affect considerably the sewage at Westborough, and care will be necessary to prevent their interfering with the operation of the sewage-disposal works.

The filters at Framingham were enlarged and improved somewhat during the past year, and the additions to the sewage-disposal works at Pittsfield in a previous year have made it practicable to dispose of the sewage of the city without the necessity of discharging large quantities into the river, as has been the case in previous years.

During the hot weather in midsummer the attention of the Department was called to a nuisance at Milford, caused by the overflow of sewage on low land in a populated section. It appears that an inverted siphon on the line of the main sewer has become inadequate for carrying all of the sewage at times of high flow. The design of the system provided for the construction of an additional siphon whenever the capacity of the first siphon had been reached. This provision has been neglected because the town has not furnished the money for the purpose. In consequence, a large pool of sewage was formed in the neighborhood of dwelling houses, which, decomposing and putrefying in hot weather, caused a most offensive nuisance and became the breeding place of great numbers of insects. The Department has recommended that a new siphon be provided before the coming of another warm season, but the work cannot, of course, be carried out unless the town shall vote to provide the money.

The sewage-disposal works at Fitchburg have operated more satisfactorily during the greater part of the year than was the case heretofore, and large quantities of organic matter have been removed from the sewage which would otherwise have polluted the Nashua River. At Brockton, also, trickling filters have been in use which have provided an effective preliminary treatment for a large part of the sewage before its application to the sand filters.

The operation of the Worcester works is described in connection with the Blackstone River.

The results of the operations carried on at the remaining works have been in general satisfactory throughout the year.

Insanitary Conditions due to Lack of Sewerage.

Very little has been done toward the removal of objectionable sanitary conditions in certain cities and towns referred to in the report of last year. In two cases investigations have been made relative to the introduction of systems of sewerage, and in one of these cases — Reading — preliminary steps have already been completed for the construction of a sewerage system in the coming year. A partial sewerage system has been provided in the town of Bridgewater.

Pollution and Protection of Rivers.

The condition of the rivers of the State has been examined as usual during the year. Special examinations were made of the Blackstone and Taunton rivers, including the various important pollutions of those streams, and a careful examination was also made of the sources of pollution of the Housatonic River to determine what changes had taken place since the previous examination of that stream. The action taken during the year toward the improvement of the Blackstone and Taunton rivers will be found in each case under the description of the conditions in the valleys of those streams in a subsequent portion of this report.

The sewage-disposal works of the city of Fitchburg have been operated during the year, and the greater portion of the sewage of the city is now removed from the north branch of the Nashua River and treated at the disposal plant. A beginning has also been made upon the separation of sewage from storm water in the districts served by the combined sewers, which cover nearly the whole sewered area of the city. A large sum of money has been expended upon the intercepting sewers and disposal works, and a marked improvement has been effected in the condition of the river in its course through the city and for a considerable distance below it.

Early in the year plans were considered and approved by the Department for the treatment of the sewage of the city of Leominster, which still grossly pollutes the north branch of the Nashua River a short distance below Fitchburg and Monoosnock Brook, a tributary of the river, into which it is discharged. It is assumed that, in view of the fact that the city of Fitchburg has now completed its works for the removal of the sewage from the north branch of the Nashua River, the construction of the works by the city of Leominster for the removal and treatment of the sewage of that city will be begun promptly in the coming spring.

The question of the disposal of sewage for the town of Webster, which now grossly pollutes the French River below that town, has been taken up by the town authorities, and investigations are now being made for a proper method of sewage disposal.

Aberjona River.

Inspections of the Aberjona River have been made from time to time during the year, and the cases of avoidable pollution by manufacturing wastes, tending to create a nuisance or cause injury to health, have received attention as soon as discovered. The character of the river water was greatly affected during the latter part of the year by the discharge of waste from a chemical company in North Woburn, which imparted to the water a greenish color and an acid reaction which affected the water throughout its course from North Woburn to the Mystic Lakes, and the Upper Mystic Lake itself became considerably affected by the acid. While careful investigations failed to show that the condition of the stream was causing injury to health or producing a nuisance, it was evidently objectionable, and the matter was taken up by the Department with the owners of the chemical works to secure relief. A system of treatment of this acid was introduced at the works, and later in the year the river ceased to show an acid reaction and had improved materially in color.

Assabet River.

The Assabet River in the upper part of its course as it passes through Westborough and Hudson has shown little change from the previous year. Below Maynard, where the river is polluted by sewage and a great quantity of manufacturing waste, its condition has been slightly better than in the previous year, and the same is true at the point at which it joins the Sudbury River at Concord.

Charles River.

A great improvement has been made in the condition of the Charles River in recent years by the construction of sewage-disposal systems at Milford and at Franklin, the latter having been completed during the past year. Practically all of the important pollutions of the river by domestic sewage in the upper portion of its course have now been removed with the exception of the sewage of the State Hospital at Medfield, which continues to pollute the river, no provision having been made for the construction of necessary additional filter beds. Farther downstream at Brookline, Newton, Wellesley and Waltham, its condition shows little change as compared with the past few years.

Chicopee River.

The Chicopee River and its main tributaries, the Quaboag, Ware and Swift rivers, receive considerable pollution from the sewage of towns. The Quaboag River is used as a place of disposal for the sewage of Palmer at a point a short distance above the mouth of the river, where the conditions have not been found seriously objectionable up to the present time. The Ware River is used as the place of disposal of the sewage of Ware, besides which this stream receives large quantities of manufacturing waste. Its condition below Ware has become more and more objectionable in recent years, and, while some improvement was shown in 1916, due doubtless to the greater flow of the stream in the early part of the summer, there is no doubt that some of the pollution of this river will have to be eliminated in the near future if the stream is to be maintained in a satisfactory sanitary condition.

The pollution of the Swift River has not become seriously objectionable up to the present time.

The Chicopee River below the confluence of its three principal tributaries receives the sewage of the town of Ludlow and a part of that of the town of Wilbraham and of the city of Chicopee. The condition of this stream in general is not seriously objectionable, and there has been no material change in its condition in the lower part of its course during the past year.

Concord and Sudbury Rivers.

The condition of the Concord River at North Billerica has been unobjectionable during the year.

The condition of the Sudbury River below the mills at Saxonville has been somewhat better than for several years, and the same is true of its condition at the point where it joins the Assabet River at Concord.

Connecticut River.

The Connecticut River receives considerable pollution in New Hampshire and Vermont before entering Massachusetts, and in its passage through Massachusetts it receives the sewage of all of the cities and larger towns along its banks. The flow of the river is great, however, compared with the quantity of sewage it receives, and its condition where it leaves the State at the Connecticut boundary shows little evidence of sewage pollution by chemical analysis.

Among the smaller tributaries of this stream as it flows through the State, the Mill River receives the sewage of Northampton at a point below that city and is seriously polluted throughout the remainder of its course. The region through which this river flows is uninhabited, however, and no complaint of its condition is made.

The Manhan River receives a considerable portion of the sewage of Easthampton and is considerably polluted thereby.

The Fort River, a tributary flowing through the town of Amherst, has been greatly improved during the past year by the diversion of the principal part of the sewage of the town to the Connecticut River.

Deerfield River.

The Deerfield River is polluted by sewage at two points, — Shelburne and Greenfield, — and receives, in addition, a very small quantity of manufacturing waste. The quantity of sewage discharged at Shelburne is so small that it has little effect on the stream. The sewage dicharged at Greenfield has a notable effect on the river at times of low flow, but its condition has not been seriously objectionable up to the present time.

French River.

The French River has become one of the most seriously polluted streams of the State, and its condition below Webster, and down to the point where it enters the State of Connecticut, is very objectionable. Plans are in preparation, however, for a system of sewage disposal which, when constructed, will relieve the stream of much of that part of its pollution which is due to the domestic sewage of Webster. The river receives considerable pollution from manufacturing waste, and it is probable that the treatment of some of the more objectionable of these wastes will be necessary in order to bring the stream into a satisfactory condition.

Hoosick River.

The sources of pollution of the Hoosick River are those caused by the sewage of the towns of Adams and Williamstown and the city of North Adams. In the portion of the course of the river below North Adams and through Williamstown the condition of the stream is highly objectionable in the drier part of the year.

Housatonic River.

The Housatonic River in 1915 showed considerable improvement as compared with previous years, and this improvement has been continued, with the result that the condition of the river has been better in 1916 than for several years. This improvement has been brought about largely by the extension and improvement of the sewage-disposal works of the city of Pittsfield and a reduction in the quantity of unpurified and partly purified sewage discharged into the river.

Merrimack River.

The condition of the Merrimack River has shown a very decided improvement over that for many years. This is especially noticeable below Lawrence, where the quantity of organic matter in the river water has been less than at any other time within the past twelve years, and the same material improvement is noted throughout the remainder of the course of the stream to its mouth. This improvement is doubtless due in part to the high flow of the river in the early part of the summer and in part to the fact that the character of the wool-scouring waste has been less objectionable than for several years. The reduction in the pollution of the river caused by scouring waste has been due to various causes, chief among which are the treatment of some of the wastes for the removal of grease and the use of wool containing less objectionable matter than usual.

Millers River.

Millers River receives considerable pollution at Winchendon, and a tributary of the river receives the effluent from the sewage-disposal works at Gardner. The river is also polluted by the sewage of the towns of Athol and Orange and receives a small amount of sewage at Millers Falls near its mouth. The condition of the river above Athol has shown but little change in many years. Below Athol the evidences of pollution in the past year have not been serious and differ but little from those of the past few years.

Below Orange the river has shown rather less evidence of sewage pollution than in the past few years, and the same is true of its condition at Millers Falls. The stream is not as yet a seriously polluted one.

Nashua River.

Reference has already been made to the fact that the city of Fitchburg has constructed intercepting sewers and sewage-disposal works by which a large part of the sewage of the city is now removed from the north branch of the Nashua River and treated for the removal of objectionable organic matters.

No work has yet been begun toward constructing works for the removal of the sewage of the city of Leominster from the river, although plans for the disposal of the sewage of the city were approved by the Department early in the year. Now that the city of Fitchburg has practically completed its works for the treatment of its sewage before discharge into the Nashua River, and has effected, in consequence, a considerable improvement in the condition of that stream, it is highly important that the city of Leominster shall proceed promptly to do its share in securing the removal of the remainder of the sewage, which has long been the cause of a serious nuisance in this stream. In view of the circumstances the Department recommends that authority be given to the city of Leominster at the present session of the Legislature to borrow the necessary money to construct its sewage-disposal works.

The condition of the river shows considerable improvement below the city of Fitchburg in consequence of the completion of the sewage-disposal works of that city. Farther downstream, however, the sewage of the growing city of Leominster has a very bad effect upon the stream, and the river continues to be badly polluted throughout its length to the junction of the south branch at Lancaster. Throughout the remaining length of the stream an improvement has been noted during the past year, though the river is still a badly polluted one.

Neponset River.

The Neponset River shows improvement in its upper waters as compared with previous years, a condition which is due in part no doubt to the unusual high flow of rivers in the early part of the summer. Throughout the Fowl Meadows, between the Canton River and Hyde Park, the stream shows little improvement as compared with the previous year, and the same is true of its condition through Hyde Park and Milton to its entrance to a tidal estuary at Milton Lower Mills.

At the tannery of the Winslow Brothers and Smith Company on Hawes Brook experiments have been carried on relative to the treatment of wastes from these works by the activated sludge process, but very little has been done toward the construction of works for the treatment of these wastes.

The Department is informed that a part of a process producing objectionable wastes at one of the paper mills at East Walpole is to be removed from this valley before another summer. Another large paper mill at this point began the construction of filters for the treatment of its mill waste during the past year.

Further action seems likely, also, to be taken by the town of Stoughton to prevent the pollution of the river by sewage in that town, and the question of sewerage in other areas is under consideration.

With the removal of a part of the objectionable wastes from the valley, if the wastes at the remaining mills shall be given efficient treatment, methods for effecting which have already been ascertained, this river can be restored to a satisfactory sanitary condition.

Westfield River.

The Westfield River receives a small amount of pollution from the sewage of the towns of Russell and Huntington, and its waters are used as a place of disposal for the sewage of the town of Westfield, which is discharged directly into the river. The river is also polluted by sewage farther downstream, in West Springfield and Agawam. The condition of the river below Westfield during the past year has not been seriously objectionable and has shown little change recently as compared with earlier years.

Other Rivers.

Of the remaining rivers in the State, the most important are the Quinebaug, which receives considerable pollution in the large town of Southbridge, and the Ten Mile River, which drains the city of Attleboro and the towns of North Attleborough and Plainville.

The condition of the Quinebaug River shows little change from previous years. It receives a very considerable amount of pollution in its flow through Southbridge, but its condition has not been objectionable during the past year.

The Ten Mile River also receives considerable pollution, but since the introduction of sewage-disposal systems in Attleboro and North Attleborough the condition of the river has shown improvement and is not seriously objectionable at the present time.

Improvement of the Fowl Meadows on the Neponset River.

By the provisions of chapter 655 of the Acts of the year 1911 and acts in addition thereto the dredging, deepening and improvement of the Neponset River for the purpose of draining the Fowl Meadows, formerly a source of malarial fever, was completed in the early part of 1915 so far as authorized by the provisions of those laws.

Under the provisions of the Resolves of the year 1915, chapter 93, the Commissioner of Health was directed to consider certain further improvements of the Neponset River and submit a report with recommendations thereon. This report was presented to the Legislature of 1916, — House Document No. 1780, — with recommendations which included a recommendation for the construction of additional channels required for the effective drainage of all parts of the Fowl

Meadows (the estimated cost of which was $55,000), and a recommendation that a sum be provided for surveying the meadows to ascertain their ownership as a basis for apportioning the portion of the cost of the improvement to be assessed on the owners of the lands benefited.

No action was taken by the Legislature upon the recommendation for improving the tributary channels in the Fowl Meadows, but provision was made, by chapter 265 of the General Acts of the year 1916, for a survey and determination of the areas benefited. This work was begun late in the summer and about 40 per cent. of it had been completed at the end of the year.

An additional appropriation was also made, under the provisions of chapter 146 of the Resolves of the year 1916, to provide for investigations as to the control and height of water in the Neponset River at the Mattapan Mills dam, which affects the elevation of the water throughout the greater part of the length of the Fowl Meadows. Observations relative to carrying out the provisions of this resolve were also begun in the latter part of the year.

The results of the investigations as to the effect of the dredging thus far done upon the drainage of the Fowl Meadows indicate that the improvement thus far made is limited to a comparatively narrow strip bordering the improved channel of the river. In the very dry weather of late September, 1916, observations in numerous test wells throughout the meadows indicated that a little less than one-third of the total area of the meadows was being drained at that time to a level of 2 feet or more below the surface of the meadow. Near the river itself the height of the ground water approximated that of the stream, the level of the ground water gradually rising as the distance from the river increased, until, at points ranging from a few hundred feet to a quarter of a mile from the stream, the ground water level was found within 2 feet of the surface of the meadows. This probably represents the limit of satisfactory drainage of these lands for agricultural purposes. Farther back from the river the ground water approaches in most places very close to the level of the meadows, while in very wet weather their surfaces are covered with water.

An examination made at the end of November shows a considerable rise in the level of the ground water, and at that time the area drained to a level of 2 feet or more below the surface of the meadows was less than a quarter of the whole. The period in which these measurements were made was one of very limited rainfall, and the results of these observations appear to show that the work thus far done, while draining effectively much of the surface of the meadows under ordinary conditions, has not materially improved the drainage of a large part of them. In places near the main river considerable work has already been done by the owners of the land in opening old ditches and constructing new ones for the effective drainage of the meadows, and in view of these circumstances it appears to the Department desirable to renew the recommendation of last year that the main tributaries of the river be deepened in order to secure the full advantages to be obtained from this improvement.

Reclamation of Wet Lands.

Under the provisions of chapter 761 of the Acts of the year 1913 the State Board of Agriculture and the State Board of Health, acting as a joint board, were authorized to purchase or take by right of eminent domain any tracts of wet lands for the purpose of drainage, and this act was supplemented by the provisions of chapter 596 of the Acts of the year 1914, giving the Joint Board further power in this matter. The aggregate sum of $25,000 was appropriated by these two acts for the purposes indicated.

Acting under these statutes the Joint Board of Agriculture and Health began investigating with reference to carrying out the provisions of these acts, but, owing to the limitations contained therein, considerable difficulty was found in securing a proper site for the purpose, and by the provisions of chapter 127 of the Special Acts of the year 1915 the appropriations provided for the purpose were made available for the employment of the unemployed in connection with the forestry work of the State, and no money now remains available for carrying out the provisions of these acts.

The swamp lands in Massachusetts cover a very large area in the aggregate and many such areas include upwards of 1,000 acres. The condition of many of the swamps is objectionable and undoubtedly detrimental to the public health and comfort, and their effective drainage is in many cases very desirable for the protection of the public health alone. In the improvement of these areas provision might be made to advantage for the employment of needy persons at times of industrial depression, especially in clearing and improving such lands after drainage.

The limited investigations made with reference to carrying out the above-mentioned statutes indicate that many of the areas of wet lands of the State contain soil of such character that these areas might be made extremely fertile by proper drainage. Such work is now being carried out in many States, but, in the opinion of the Department, it is advisable, before undertaking this work in Massachusetts, that a thorough investigation of the subject be made to determine the necessity and probable advantages to be obtained from such improvements. In order to secure this information a general survey of these lands should first be made to determine the areas that can be most advantageously drained with reference to the improvement of the public health, and to ascertain the probable value of such areas, after draining, for agricultural purposes and the probable extent and cost of the necessary drainage works. It is advisable also that the great areas of salt marshes that border the sea coasts and tidal estuaries should be included in the investigations, since these areas are to a large extent a source of objection from insect life in the warmer season of the year, and they also can, no doubt, be made sufficiently valuable for agricultural uses to warrant their effective drainage.

These investigations would require considerable time, and, in the opinion of the Department, an appropriation of $15,000 would make it practicable to determine definitely the areas of wet lands which require improvement and can be improved to the best advantage, and the best methods and plans of doing the work.

Pollution of the Blackstone River.

The condition of the Blackstone River has been the subject of careful investigation during the past year in connection with an act passed by the Legislature earlier in the year which authorized the connection of the Worcester State Hospital sewerage system with that of the city of Worcester, subject to acceptance by the city of Worcester and to the following special conditions: —

> . . . *provided, however,* that no such connection between the said hospital and the Worcester system of sewerage shall be made unless the state department of health, after making a thorough investigation of the sewerage conditions of the Blackstone river and the conditions surrounding the present method of disposal of the sewage of the said hospital, shall certify to the auditor of the commonwealth that it is desirable from the point of view of the public health that the Worcester state hospital shall be connected with the sewerage system of the city of Worcester.

This act, chapter 363 of the Special Acts of the year 1916, was accepted by the city of Worcester on June 19, 1916, and subsequently the State Department of Health was requested to investigate the condition of the Blackstone River and the conditions surrounding the present method of the disposal of sewage of the Worcester State Hospital for the purpose of taking action under the provisions of the above-mentioned act.

A thorough investigation was accordingly made by the Department to determine the sources of pollution of the Blackstone River and its general condition as compared with previous years. The conditions affecting the disposal of the sewage of the Worcester State Hospital were also carefully considered by the Department, and it was found that a nuisance now exists and has been maintained for several years on the grounds of the hospital in the immediate neighborhood of a large population bordering Lake Quinsigamond. This condition was brought about by the fact that, until the present year, no money has been provided for the proper disposal of this sewage.

It appeared to the Department very important to secure the abolition of this nuisance at the earliest practicable time, but it did not appear desirable that the great nuisance already existing in the Blackstone valley should be increased permanently by the addition of the hospital sewage to that of the city of Worcester. Furthermore, it is obvious that the city of Worcester must very soon provide a much more efficient system of sewage disposal than that now in use, and, anticipating this necessity, the department of the city government having charge of sewerage has already made a series of thorough experiments with reference to the best practicable methods of improving its system of sewage disposal. The results of these experiments are presented in the report of the sewer department of the city of Worcester, the more important conclusions being as follows: —

> From the results of operation of this experimental plant it appears to be perfectly feasible to treat Worcester sewage by means of Imhoff tanks and sprinkler filters. Results of experimental treatment of chemical effluent indicated that the advantages gained by chemical precipitation as a preliminary treatment were not commensurate with the cost. The Imhoff tank was quite as efficient in sludge-digestion as experimental septic tanks have been and much more efficient so far as the sedimentation of the sewage is concerned. It was operated without the production of the offensive odors characteristic of the septic tank and the sludge itself was disposed of without creating a nuisance. The effluent from the Imhoff tank was normally as fresh in appearance and odor as the sewage flowing into the tank.
>
> More than twenty times as much sewage per unit of area was treated by the sprinkler filters as could be treated by intermittent sand filtration and more than ten times as much per cubic yard of filter. Four times as much sewage was treated by these experimental filters as could be treated satisfactorily by experimental contact beds. In order to obtain equal nitrification with contact beds, at least three contacts would be required.
>
> Judging from this experimental plant, the cost of operation of Imhoff tanks

and sprinkler filters per million gallons of sewage treated would be very much less than the cost of operation of chemical precipitation or sand filtration as carried on at Worcester.

It is believed that the results of operation of this experiment plant given in this report will furnish the basic data necessary for the design of Imhoff tanks and sprinkler filters for the treatment of Worcester sewage.

The following statement relative to the necessity for enlarging the Worcester purification works is taken from the report of the sewer department of the city of Worcester for the year 1915: —

> Worcester is a rapidly growing city and although the records for the year show an improvement in the condition of the Blackstone River, due to the work of the new outfall sewer, it is evident that the purification plant must soon be enlarged. This enlargement, for well-established reasons, must be along new lines. The present plant need not be entirely abandoned, but can be utilized at certain periods to good advantage.
>
> Our experimental work has shown that Worcester sewage after settling out the solids in an Imhoff tank can be successfully treated on sprinkler filters at the rate of 2,000,000 gallons per acre per day. It is our experience, confirmed by that of other cities, that this process can be employed without causing offensive odors. Moreover, with this method, the reduction in the annual maintenance cost alone would nearly pay the interest charges on the new plant. Anticipating its needs, the department several years ago acquired the necessary land. It is situated just over the Millbury line and is well adapted for the purpose, being remote from dwellings and covered with a heavy growth of trees.

In view of the fact that the city has already recognized that its purification works must be enlarged and that the experiments already made show that in effecting this enlargement the cost of maintenance would be so reduced as to nearly pay the interest charges on the increased plant, and in view of the serious nuisance now existing at Lakeview and the further powers of this Department under the provisions of chapter 433 of the Acts of the year 1909, the Department at its meeting on Aug. 31, 1916, voted to certify to the Auditor of the Commonwealth that it was desirable, from the point of view of the public health, that the State Hospital should be connected with the sewerage system of the city of Worcester.

The Department subsequently notified the city of Worcester of a hearing or conference relative to the construction of additional works for the purification of the sewage of the city, and at this conference the question of the construction of these works was considered. It appears that the city of Worcester desires to investigate the applicability of the so-called activated sludge process for sewage purification to the problem of sewage treatment at Worcester before proceeding with the construction of the works designed on the basis of its recent experiments. It appears to the Department that these experiments need not take any very considerable time, and that, if they were begun promptly at the time the matter was first taken up with the authorities of the city of Worcester early in November last, the experiments could be completed within a year. The so-called activated sludge process of sewage purification has not yet passed the experimental stage and has not been applied to actual practice on a large scale. In the tests thus far made, it appears to be as efficient, possibly somewhat more efficient, than the Imhoff tank and trickling filter, so far as eliminating organic matters from the sewage is concerned; but it is evident that the cost of the operation of such works will be large, unless power can be obtained at extremely small rates, and no information is available as yet as to the cost of maintenance and renewal of plant. Considering what is already known of the activated sludge process, it does not seem likely that any long period will be required to determine definitely the applicability of this process to the problem of sewage disposal of the city of Worcester, assuming that the city proceeds with the experiments without unnecessary delay.

At the hearing referred to and in subsequent communications the authorities of the city of Worcester assured the Department that the city would proceed with the experiments and would secure from the Legislature authority to borrow sufficient money to construct the works necessary for the effective treatment of the sewage of the city. Under the circumstances, the Department has postponed further action in this matter, pending the carrying out of these assurances, and recommends that authority be given the city of Worcester at the present session of the Legislature to borrow the necessary money to carry out this work.

Results of the Examination of the Blackstone River.

Briefly stated, the examination of the Blackstone River in 1916 revealed practically the same conditions as were found in the course of the examination in 1913, the results of which were published in the annual report for that year. Along the upper waters of the Blackstone River in Leicester and Worcester there are numerous mills which discharge into the stream considerable quantities of wash water from their various processes, the effect of which is to impart to the stream a noticeable color and to increase materially the quantity of organic matter in the water. These organic matters are largely of a carbonaceous origin, and, while affecting unfavorably the appearance of the river at times of low flow, were not at the time of the recent examination causing a nuisance or producing conditions injurious to the public health. It is probable that the objectionable portions of the wastes which cause the pollution of the river in this region could be removed at the factories at a comparatively small cost, as the Department has already advised.

Farther downstream the river receives additional pollution from scattered mills, but at the point where it enters the city of Worcester its condition is not objectionable from a sanitary point of view.

The most serious pollution of the river is that which is caused by the discharge of sewage and effluent from the treatment works of the city of Worcester. The quantity of sewage treated at the disposal works of the city of Worcester in each year since their construction is shown in the following table: —

Quantity treated in Million Gallons.

YEAR.	Total.	Average per Day.	YEAR.	Total.	Average per Day.
1890,	391	1.071	1903,	5,676	15.552
1891,	1,398	3.830	1904,	4,622	12.629
1892,	842	2.301	1905,	4,319	11.834
1893,	1,795	4.918	1906,	5,357	14.677
1894,	4,562	12.499	1907,	5,679	15.559
1895,	5,730	15.699	1908,	5,615	15.342
1896,	5,840	15.957	1909,	5,265	14.425
1897,	6,205	17.000	1910,	5,317	14.567
1898,	6,460	17.698	1911,	5,421	14.852
1899,	6,241	17.097	1912,	5,807	15.870
1900,	4,781	13.100	1913,	6,610	18.110
1901,	3,565	9.768	1914,	6,638	18.186
1902,	4,842	13.267	1915,	5,994	16.422

The quantity of sewage treated at the works in the years 1900–12, inclusive, was considerably less than in the four years immediately preceding 1900. While this decrease was due in large measure to the extension of the separate system of sewers, it was also doubtless due to a considerable extent to a deficiency in the rainfall in those years and a consequent decrease in the quantity of storm water discharged into the system from the many miles of combined sewers still in use. The total length of sewers in the city of Worcester and the extent of the separate and combined systems are shown in the following table: —

Length of Sewers in Miles.

Year.	Separate.	Combined.	Separate and Combined.	Storm Water only.	Separate, Combined and Storm Water.
1885,	-	-	-	-	50.94
1886,	-	-	-	-	56.41
1887,	-	-	-	-	62.89
1888,	-	-	-	-	68.02
1889,	-	-	-	-	71.39
1890,	-	-	-	-	76.59
1891,	-	-	-	-	80.94
1892,	-	-	-	-	85.44
1893,	-	-	-	-	90.04
1894,	-	-	-	-	95.42
1895,	-	-	-	-	99.29
1896,	-	-	-	-	102.69
1897,	-	-	-	-	112.01
1898,	-	-	-	-	121.97
1899,	-	-	-	-	134.14
1900,	-	-	-	-	151.09
1901,	-	-	-	-	158.47
1902,	-	-	-	-	162.75
1903,	69.01	61.64	130.65	38.66	169.31
1904,	70.85	61.91	132.76	40.21	172.97
1905,	72.95	62.25	135.20	41.61	176.81
1906,	73.89	62.95	136.84	42.72	179.56
1907,	75.91	63.47	139.38	43.66	183.04
1908,	79.18	64.09	143.27	44.45	187.72
1909,	81.82	64.78	146.60	45.65	192.25
1910,	85.06	64.99	150.05	48.60	198.65
1911,	88.38	65.78	154.16	51.16	205.32
1912,	93.32	66.05	159.37	53.72	213.09
1913,	99.44	68.68	168.12	54.08	222.20
1914,	103.39	69.03	172.42	56.11	228.53
1915,	106.13	69.32	175.45	59.18	234.63

The quantity of sewage treated in 1913 and 1914 was greater than in any other year since the works were constructed, averaging slightly over 18,000,000 gallons per day in each of those years. In 1915 the quantity treated was about 10 per cent. less than in the preceding year, and, while greater than the amount treated in any year since

1900, with the exception of the years 1913 and 1914, was less than the amount treated in the three years previous to 1900. The decrease in the amount treated in 1915 is accounted for in part at least by the small quantity treated at the works during one month when work was being completed upon a new outfall sewer; but for this, the total quantity of sewage treated in the year 1915 would have been as great as, if not greater than, that treated in the two previous years. The great increase in the quantity of sewage treated at the works during the past three years is due to the construction of the new outfall sewer, which delivers a greater flow to the disposal works at times of storm than could be delivered through the old outfall sewer.

The sewage of the city of Worcester is unusually strong and contains a large amount of waste from iron works, where large quantities of acid are used, and the sewage consequently contains a varying amount of sulphate of iron, and at times free acid. Large quantities of waste from wool scouring, dyeing, tanning, and other manufacturing processes, are also discharged into the sewers, and the character of the sewage is also greatly influenced by the amount of storm water with which it is mingled.

After passing through grit chambers at the disposal works, a part of the sewage, usually the heavier sewage, is discharged through settling tanks to the sand filter beds, while the remaining portion, after being mixed with chemicals, flows to the precipitation tanks and is discharged thence to the river. The chemical used in the precipitation tanks is lime, which is added to the sewage in the form of milk of lime, the quantity added being determined largely by the quantity of sulphate of iron present in the sewage when it arrives at the disposal works. About 1,000 pounds of lime per 1,000,000 gallons were used in the year 1915. The total quantity of sewage treated in the different years by chemical precipitation and by intermittent filtration is shown in the following table: —

Year.	Quantity treated.			
	Chemical Precipitation.		Intermittent Filtration.	
	Total (Million Gallons).	Per Cent. of Total.	Total (Million Gallons).	Per Cent. of Total.
1905,	3,689	85.4	597	13.8
1906,	4,256	79.4	1,093	20.4
1907,	4,551	80.1	1,106	19.5
1908,	4,114	73.3	1,472	26.2
1909,	3,686	70.0	1,558	29.6
1910,	3,580	67.3	1,722	32.4
1911,	3,610	66.6	1,792	33.0
1912,	4,201	72.4	1,560	26.8
1913,	5,170	78.2	1,408	21.3
1914,	4,947	74.5	1,691	25.5
1915,	4,367	72.8	1,627	27.2

It will be seen from this table that the quantity of sewage treated by chemical precipitation in 1905 was 85.4 per cent. of the total quantity received at the works, while in 1915 it had decreased to 72.8 per cent., owing to the increase in the amount treated upon the sand filters.

Analyses of the sewage and effluent are made regularly by the chemist at the disposal works, and from the printed results of these analyses the following table has been prepared showing the purification effected by the various processes employed: —

Purification effected by Chemical Precipitation and Filtration (All Methods).

YEAR.	FREE AMMONIA.			TOTAL ALBUMINOID AMMONIA.			OXYGEN CONSUMED.			Average Flow in Million Gallons per Day.
	Sewage.	Effluent.	Per Cent. removed.	Sewage.	Effluent.	Per Cent. removed.	Sewage.	Effluent.	Per Cent. removed	
1901, . . .	1.786	1.454	18.59	.632	.234	62.98	8.83	3.45	60.94	9.43
1902, . . .	2.059	1.763	14.37	.810	.383	52.74	11.02	4.10	62.81	12.54
1903, . . .	1.769	1.467	17.07	.832	.372	55.31	9.39	4.07	56.65	15.55
1904, . . .	1.955	1.598	18.27	.840	.346	58.80	10.05	4.49	55.34	12.63
1905, . . .	2.035	1.824	10.40	.926	.358	61.50	11.96	5.00	58.20	11.79
1906, . . .	2.026	1.822	10.10	.917	.374	59.20	12.63	4.98	60.60	14.65
1907, . . .	2.042	1.738	14.90	.856	.390	54.40	11.91	4.76	60.00	15.60
1908, . . .	2.217	1.783	19.60	.860	.384	55.30	11.77	4.70	60.10	15.26
1909, . . .	2.406	1.976	17.90	.825	.360	56.40	12.74	4.88	61.70	14.37
1910, . . .	2.473	1.974	20.20	.861	.358	58.40	13.52	5.25	61.20	14.53
1911, . . .	2.555	2.179	14.70	.929	.390	58.00	16.47	6.33	61.50	14.80
1912, . . .	2.299	1.972	14.20	.873	.369	57.70	14.20	5.64	60.30	15.74
1913, . . .	2.123	1.733	18.40	.721	.368	49.00	13.66	5.57	59.30	18.02
1914, . . .	2.010	1.550	22.70	.760	.335	55.90	12.78	5.33	58.30	18.18
1915, . . .	1.940	1.490	23.20	.725	.298	58.90	14.05	4.72	66.40	16.42

The only other sewerage system of considerable size within the watershed of the Blackstone River in Massachusetts, aside from that of the city of Worcester, is that at Whitinsville in the town of Northbridge, where the sewage of about 6,000 people is treated by intermittent filtration and the effluent discharged into one of the tributaries of the Blackstone River not far from the main stream. The purification of the sewage is satisfactory at the present time, and the effect of the discharge of the effluent into the stream is unobjectionable.

While the only systems of public sewers within that portion of the watershed of the Blackstone River lying above the Rhode Island line are those in Worcester and Northbridge, there are small sewers and also storm water drains, which in some cases receive small quantities of sewage, serving small populations in Millbury, Grafton, Uxbridge, Millville and Blackstone, which discharge directly into the Blackstone River or its tributaries. The aggregate population connected with these sewers at the present time, as nearly as can be ascertained, is about 850. A considerable quantity of sewage is also discharged directly into the river and its tributaries from numerous factories and mills located at widely scattered points throughout the valley. The aggregate quantity of sewage discharged into the river in this way is probably equivalent to that from a permanent population of about 5,600.

Finally, the river receives much pollution from manufacturing wastes discharged into the river at numerous points throughout its course below Worcester. In the course of the investigation somewhat over 100 mills in the valley of the river and its tributaries were examined and pollution was found to be entering the river from 72 of these works, the pollution ranging from a very slight amount of weak acid or bleach liquor, which have little effect upon the stream, to the more serious pollutions caused by woolen and paper mills, especially by wool scouring, of which a considerable amount is done at several points in the valley. The details relating to the pollution of the stream are presented in a table appended hereto. The aggregate amount of organic matter contained in all the pollution from the mills is much less than that contained in the effluent from the sewage-disposal system of the city of Worcester. Nevertheless, the more serious of these pollutions should be discontinued, especially those resulting from wool scouring, which contain a quantity of organic matter which greatly exceeds that found in ordinary sewage.

Condition of the River.

The condition of the Blackstone River has been observed at several points for many years by means of chemical analyses of samples collected monthly in the period from June to November of each year, and the results of these tests covering the period from 1908 to 1916 are given in the following tables: —

Below Cherry Valley.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Iron.
					Albuminoid.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908, . . .	–	20.57	3.83	.1531	.0624	.0508	.0116	5.76	.0020	.0007	.99	–
1909, . . .	.35	13.93	3.34	.0681	.0470	.0334	.0136	3.70	.0125	.0003	.80	–
1910, . . .	.32	16.42	3.92	.0633	.0489	.0387	.0102	4.02	.0146	.0002	.85	–
1911, . . .	–	21.02	4.40	.1277	.0726	.0559	.0167	5.70	.0080	.0005	1.15	–
1912, . . .	–	44.10	11.04	.2514	.2884	.1023	.1861	10.70	.0002	.0004	3.08	–
1913, . . .	–	32.32	6.52	.2591	.1628	.1122	.0506	8.18	.0015	.0004	2.06	–
1914, . . .	–	44.73	7.27	.3430	.1856	.1379	.0477	12.83	.0000	.0001	2.12	–
1915, . . .	–	19.23	5.15	.0985	.1142	.0785	.0357	3.08	–	–	1.89	–
1916, . . .	–	14.18	5.27	.0209	.0809	.0544	.0265	1.25	–	–	1.50	–
Above Worcester Sewage-disposal Works.												
1908, . . .	.16	23.67	5.55	.0990	.0291	.0153	.0138	3.23	.0134	.0014	.83	3.327
1909, . . .	–	52.97	18.55	.1865	.0381	.0239	.0142	4.80	.0033	.0010	2.09	8.440
1910, . . .	.15	50.92	18.97	.1933	.0545	.0309	.0236	4.07	.0023	.0009	2.19	11.850
1911, . . .	.11	44.64	15.70	.1920	.0449	.0212	.0237	4.03	.0170	.0009	2.05	8.167
1912, . . .	.10	40.05	10.91	.2047	.0352	.0225	.0127	3.58	.0027	.0011	1.69	6.667
1913, . . .	.10	35.17	10.34	.2767	.0491	.0285	.0206	3.18	.0003	.0008	1.31	4.933
1914, . . .	.14	35.03	8.23	.2993	.0771	.0510	.0261	3.85	.0012	.0018	1.41	3.817
1915, . . .	.13	39.00	11.68	.2383	.0650	.0392	.0258	2.96	–	–	1.50	7.233
1916, . . .	–	29.10	8.20	.2483	.0549	.0354	.0195	2.08	–	–	1.38	3.395
Below Entrance of Chemically Treated Sewage.												
1908, . . .	.30	38.80	7.63	.9407	.1490	.0781	.0709	5.34	.0040	.0033	1.31	4.017
1909, . . .	–	53.79	12.12	1.0567	.1282	.0792	.0490	6.92	.0067	.0075	1.72	6.333
1910, . . .	–	52.15	12.52	1.0090	.1654	.0817	.0837	5.68	.0015	.0034	2.17	5.683
1911, . . .	.21	53.25	13.15	.9967	.1608	.0651	.0957	6.54	.0152	.0072	2.26	6.067
1912, . . .	.23	48.90	10.08	1.1700	.1673	.0904	.0769	6.12	.0137	.0096	2.40	4.017
1913, . . .	.28	40.68	10.46	.9320	.1286	.0719	.0567	4.49	.0158	.0084	1.79	2.960
1914, . . .	.25	43.46	9.08	.8577	.1114	.0770	.0344	4.87	.0038	.0091	1.43	2.717
1915, . . .	.13	39.45	6.77	.6370	.1032	.0575	.0457	3.58	–	–	1.55	4.125
1916, . . .	–	49.21	9.00	.6684	.1031	.0607	.0424	3.69	–	–	1.50	4.625

Below Sewage-disposal Works.

[Parts in 100,000.]

Year.	Color.	Residue on Evaporation.		Ammonia.				Chlorine.	Nitrogen as		Oxygen consumed.	Iron.
		Total.	Loss on Ignition.	Free.	Albuminoid.				Nitrates.	Nitrites.		
					Total.	Dissolved.	Suspended.					
1908, . .	.46	37.70	6.82	1.1317	.1362	.0919	.0443	6.80	.0078	.0040	1.28	1.383
1909, . .	–	48.82	9.29	1.2200	.1072	.0777	.0295	8.20	.0140	.0069	1.49	3.533
1910, . .	–	52.38	11.13	1.3033	.1265	.0892	.0373	8.07	.0108	.0046	1.85	3.867
1911, . .	.20	48.98	7.93	1.2633	.1150	.0709	.0441	8.88	.0255	.0123	1.74	2.550
1912, . .	.32	52.23	7.77	1.7895	.1223	.0777	.0446	8.14	.0118	.0098	1.82	3.317
1913, . .	.27	45.67	9.64	1.1267	.1228	.0788	.0440	6.41	.0195	.0078	1.61	2.242
1914, . .	.47	54.78	10.08	1.4967	.1970	.1418	.0552	8.52	.0215	.0248	1.99	.883
1915, . .	.31	45.83	6.93	.9133	.1193	.0680	.0513	5.65	–	–	1.14	1.958
1916, . .	–	44.36	8.57	.9035	.1431	.0798	.0633	5.57	–	–	1.68	1.130

At Millbury.

1908, . .	–	40.63	6.34	1.3424	.1642	.0980	.0662	9.31	.0040	.0016	1.64	.946
1909, . .	–	44.57	8.05	1.3500	.0957	.0740	.0217	8.59	.0026	.0066	1.27	1.056
1910, . .	.23	46.98	9.93	1.2177	.1037	.0609	.0428	8.16	.0027	.0030	1.36	1.817
1911, . .	.61	46.70	8.72	1.2283	.0990	.0602	.0388	7.82	.0077	.0016	1.24	.990
1912, . .	–	42.25	7.77	1.4633	.1632	.0880	.0752	7.21	.0006	.0025	2.23	1.397
1913, . .	–	60.32	11.85	1.0610	.2085	.0852	.1233	6.07	.0155	.0151	2.53	2.668
1914, . .	–	45.02	7.42	1.4017	.1717	.0920	.0797	7.67	.0002	.0000	1.76	.722
1915, . .	.39	64.72	14.55	.9280	.2562	.0758	.1804	5.28	–	–	3.54	5.750
1916, . .	–	43.48	8.54	.8552	.1382	.0663	.0719	4.18	–	–	1.88	5.933

At Uxbridge.

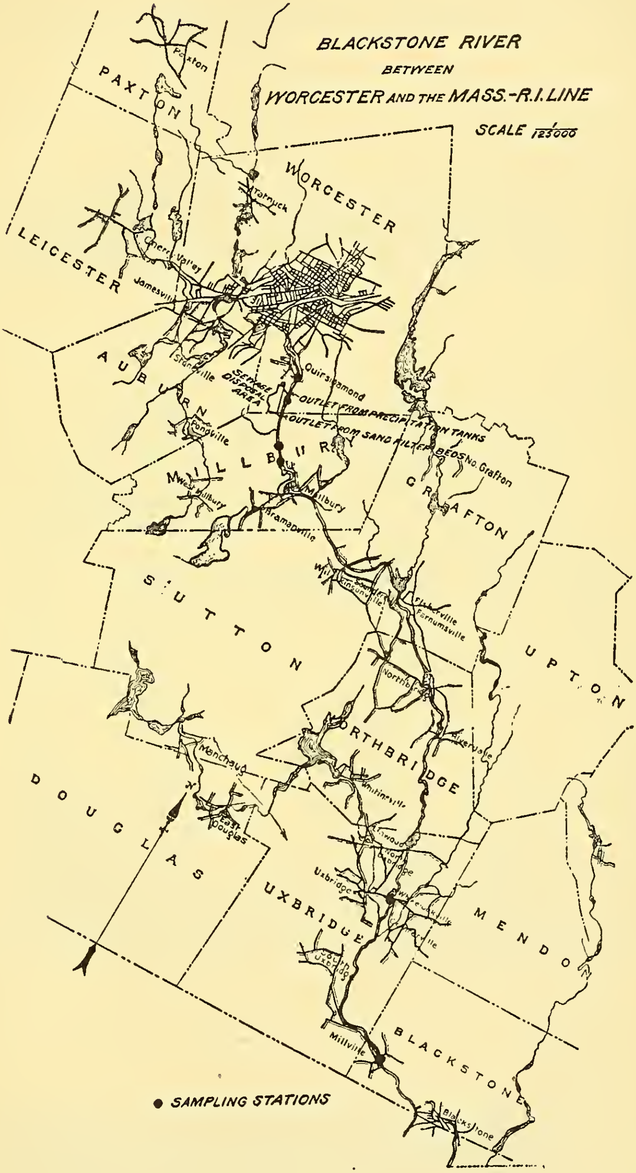
1908, . .	.31	16.33	4.07	.2387	.0253	.0196	.0057	3.05	.0408	.0071	.32	–
1909, . .	.22	18.31	4.35	.3473	.0273	.0216	.0057	3.64	.0325	.0066	.36	–
1910, . .	.26	22.53	4.69	.4963	.0356	.0302	.0054	4.62	.0498	.0043	.41	.090
1911, . .	.26	23.10	3.85	.3717	.0293	.0225	.0068	4.15	.0558	.0173	.44	.074
1912, . .	.21	21.91	3.06	.4897	.0345	.0288	.0057	4.06	.0497	.0137	.45	.093
1913, . .	.29	19.48	3.70	.3880	.0355	.0281	.0074	3.34	.0382	.0107	.49	.096
1914, . .	.25	23.72	2.84	.5285	.0355	.0284	.0071	4.55	.0482	.0154	.45	.066
1915, . .	.30	19.63	2.75	.3068	.0381	.0302	.0079	3.10	–	–	.47	.111
1916, . .	.32	20.42	4.72	.3766	.0376	.0293	.0083	2.74	–	–	.49	.140

At Millville.

[Parts in 100,000.]

YEAR.	Color.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	NITROGEN AS		Oxygen consumed.	Iron.
					ALBUMINOID.							
		Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		Nitrates.	Nitrites.		
1908, . .	.33	9.85	2.53	.1295	.0232	.0185	.0047	1.78	.0258	.0024	.34	–
1909, . .	.24	11.87	3.17	.1595	.0267	.0220	.0047	2.27	.0225	.0019	.38	–
1910, . .	.30	13.94	3.32	.2350	.0277	.0234	.0043	3.01	.0290	.0013	.37	.087
1911, . .	.33	14.35	2.79	.1787	.0268	.0222	.0046	2.94	.0355	.0051	.43	.054
1912, . .	.29	15.20	2.18	.2433	.0283	.0249	.0034	2.91	.0421	.0064	.43	.074
1913, . .	.37	12.92	2.38	.1631	.0281	.0237	.0044	2.44	.0345	.0063	.42	.065
1914, . .	.28	14.33	2.78	.2245	.0304	.0243	.0061	2.78	.0233	.0065	.40	.081
1915, . .	.42	13.55	2.02	.1379	.0361	.0267	.0094	2.12	–	–	.48	.087
1916, . .	.38	13.31	2.78	.2284	.0266	.0199	.0067	1.86	–	–	.48	.091

The results of these tests show that above Worcester the condition of the river is not very different from its condition in the last few years. The results of analyses of the river water above the sewage-disposal works show that the quantity of iron in the stream in recent years has become many times greater than the amount formerly present, and, owing to chemical changes produced by the mingling of the effluent from the Worcester sewage-disposal works with the river water, iron is precipitated, this precipitation being accompanied by that of other soluble organic matters in the sewage, and these conditions aid in producing a deposit along the bed and banks of the river which is unsightly and becomes extremely offensive on standing. The bed and banks of the river as far down as the State line are covered with a reddish brown deposit, and the mill ponds contain large accumulations of it, which, when undergoing putrefaction, give off very offensive odors. The water of the river has a very objectionable appearance throughout its entire course from the sewage-disposal works of the city of Worcester to the State line. While there are many places along the river below Worcester at which polluting matters are discharged directly into the stream, chiefly from factories and mills, it is probable that the amount and character of such matters have not changed materially during the period covered by the series of analyses given above. The analyses show that the condition of the river improved for a time after the construction of the sewage-disposal works, but that it has deteriorated in recent years and at Uxbridge and Blackstone is becoming more seriously polluted than at earlier times. There is no doubt that the present objectionable conditions will grow constantly worse until the sewage of the city of Worcester is given more efficient treatment than is the case at the present time; and since the construction of additional works will require considerable time, they should be undertaken with as little delay as possible in order that they may be operated in time to avoid the further long continuance of the intolerable conditions which now exist throughout a large part of the Blackstone River Valley.



BLACKSTONE RIVER
BETWEEN
WORCESTER AND THE MASS.-R.I. LINE

SCALE $\frac{1}{125000}$

● SAMPLING STATIONS

Pollution of the Blackstone River.

Reference Number.	TOWN.	TRADE WASTE LIQUORS.		DISPOSAL OF —		Number of Employees.
		Kind.	Gallons per Day.	Trade Wastes.	Sewage.	
1	Leicester,	Cloth scour and rinse,	91,000	Kettle Brook,	Brook,	125
2	Leicester,	Cloth scour and rinse,	66,000	Kettle Brook,	Brook,	85
3	Leicester,	None,	None.	– – –	Brook,	18
4	Leicester,	Cloth scour and rinse and rinse after bleach.	14,500	Kettle Brook,	Brook,	100
5	Leicester,	Cloth scour, rinse and dyes,	45,500	Kettle Brook,	Brook,	115
6	Worcester,	Cloth scour, rinse and dyes,	78,900	Kettle Brook,	Sewer,	175
7	Worcester,	Cloth scour, rinse and dyes,	37,000	Kettle Brook,	Cesspool,	50
8	Worcester,	Cloth scour, rinse and dyes,	8,000	Kettle Brook,	Cesspool,	40
9	Worcester,	None,	None.	– – –	Cesspool,	100
79	Worcester,	None,	None.	– – –	Cesspool,	60
17	Worcester,	Slight amount of oil,	–	Tatnuck Brook,	Sewer,	180
80	Worcester,	Cloth scour, rinse and dyes,	36,650	Tatnuck Brook,	Privy,	45
81	Worcester,	Rinse water and acid,	Small amount.	Tatnuck Brook,	Cesspool,	12
18	Worcester,	Slight amount of oil,	–	Tatnuck Brook,	Sewer,	35
19	Worcester,	Condenser water and slight amount of oil.	–	Middle River,	Sewer,	36
20	Worcester,	Pickling liquor and rinse,	Large amount.	– – –	Sewer,	625
21	Worcester,	None,	None.	– – –	Sewer,	250-600
22	Worcester,	Slight amount of oil,	–	Middle River,	Sewer,	800
23	Worcester,	Bleach liquors,	30,400	Bleach liquor to river,	Sewer,	175

24[1]	Worcester,	-	-	-	-	-
82	Worcester,	None,	None.	-	Sewer,	118
83	Worcester,	None,	None.	-	Sewer,	7
25	Worcester,	Cloth scour, rinse and dyes,	-	Sewer,	Sewer,	140
26	Worcester,	Wool scouring liquor and dyes,	-	Sewer,	Sewer,	700
84	Worcester,	Wool scouring liquor,	-	Sewer,	Sewer,	300
27	Worcester,	Bleach and dye liquors,	-	Sewer,	Sewer,	37
28	Worcester,	None,	None.	-	Sewer,	100
29	Worcester,	Oil, acid and soap,	Small amount.	Sewer and river,	Sewer,	200
85	Worcester,	None,	None.	-	Sewer,	800
86	Worcester,	Wash water,	200,000	Mill Brook,	Sewer,	1,500
87	Worcester,	None,	None.	-	Sewer,	300
88	Worcester,	None,	None.	-	Sewer,	500
89	Worcester,	None,	None.	-	Sewer,	85-100
90	Worcester,	None,	None.	-	Sewer,	160
91	Worcester,	Soap, oil, acid, etc.,	Large amount.	Mill Brook,	Sewer,	300
92	Worcester,	None,	None.	-	Sewer,	100
31	Worcester,	Acids and rinse water,	-	Sewer and brook,	Sewer,	2,100
93	Worcester,	None,	None.	-	Sewer and privy,	-
94	Worcester,	Ammonia, tar, etc.,	46,000	Mill Brook,	Sewer,	170
30	Worcester,	Acid, rinse water, oil, etc.,	-	Blackstone River,	Sewer,	2,750
11	Auburn,	None,	None.	-	Kettle Brook,	55
13	Auburn,	Cloth scour, rinse and dyes,	25,800	Ramshorn Brook,	Brook,	100

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[1] Building unoccupied at time of examination.

Pollution of the Blackstone River — Continued.

Reference Number.	Town.	Trade Waste Liquors.		Disposal of —		Number of Employees.
		Kind.	Gallons per Day.	Trade Wastes.	Sewage.	
12	Auburn,	Dust,	–	Ramshorn Brook,	Brook,	3
10	Auburn,	Water from vapor tower; floor drainage, washing of suets, etc.	Large amount.	Middle River,	River,	77
14	Millbury,	Scour liquor and rinse,	468,800	Ramshorn Brook,	Brook,	8
16	Millbury,	Scour liquor, rinse and neutral liquor.	128,900	Ramshorn Brook,	Brook,	10
15	Millbury,	None,	None.	– – –	Brook,	7
36	Millbury,	Bleach and dye liquors,	230,000	Singletary Brook,	Cesspool,	100
35, 37, 38, 40	Millbury,	Cloth scour, rinse and dyes,	213,700	Singletary Brook,	Brook,	375
39	Millbury,	Scouring and neutral liquors,	8,000	Singletary Brook,	Brook,	25
41	Millbury,	None,	None.	– – –	Brook,	30
32	Millbury,	Felt scour, rinse and dyes,	98,600	Blackstone River,	River,	150
33	Millbury,	None,	None.	– – –	River,	16
34	Millbury,	None,	None.	– – –	River,	46
42	Millbury,	None,	None.	– – –	River,	35
95	Millbury,	None,	None.	– – –	River,	40
43[1]	Millbury,	– – –	–	– – –	– – –	–
44	Millbury,	None,	None.	– – –	Cesspool,	35
45	Millbury,	Slight amount of oil,	–	Swamp,	– – –	–
46	Millbury,	Dye liquors and rinse,	25,000	Blackstone River,	River,	210
47	Millbury,	None,	None.	– – –	Cesspool,	50

48	Millbury,	None,	None.	- - -	Brook,	3
96	Millbury,	Condenser water,	Large amount.	Blackstone River,	Cesspool,	28
97	Millbury,	None,	None.	- - -	Cesspool,	12
98	Sutton,	None,	None.	- - -	Cold Spring Brook,	40
49	Sutton,	None,	None.	- - -	Cesspool,	250
59	Sutton,	None,	None.	- - -	Cesspool,	440
50	Grafton,	None,	None.	- - -	Cesspool,	200
51	Grafton,	None,	None.	- - -	River,	600
52	Grafton,	Wash water, blacking, etc.,	100	Cesspool overflow to swamp,	Cesspool,	265
53	Grafton,	None,	None	- - -	Cesspool,	3
54	Grafton,	None at present,	-	River when washing,	Cesspool,	7
99	Grafton,	Wash water, glue, paste, etc.,	Small amount.	Cesspool to swamp,	Cesspool,	20
55	Grafton,	Bleach liquors,	102,300	Quinsigamond River,	River,	75-200
56	Grafton,	Cloth scour, rinse and dyes,	324,000	Blackstone River,	River,	320
57	Northbridge,	None,	None.	- - -	Privies,	900
58	Northbridge,	Dyes, paste and rinse water,	-	Blackstone River,	Cesspool,	100
63	Northbridge,	Pickling liquors and rinse,	-	Mumford River,	Sewer,	50
64	Northbridge,	Pickling liquors and rinse,	-	Mumford River,	Sewer,	2,700
65	Northbridge,	None,	None.	- - -	Vault,	200
66	Northbridge,	None,	None.	- - -	Cesspool,	300
60	Douglas,	Cloth scour, rinse and dyes,	158,000	Mumford River,	River,	200
61	Douglas,	None,	None.	- - -	River,	22
62	Douglas,	Cloth scour, rinse and dyes,	103,000	Mumford River,	River,	230

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[1] Building unoccupied at time of examination.

Pollution of the Blackstone River — Concluded.

Reference Number.	Town.	Trade Waste Liquors.		Disposal of —		Number of Employees.
		Kind.	Gallons per Day.	Trade Wastes.	Sewage.	
67	Uxbridge,	Suds and rinse water,	6,000	Mumford River,	River,	8
68	Uxbridge,	None,	None.	- - -	Cesspool,	160
69	Uxbridge,	None,	None.	- - -	Septic tank to Clear River,	75
70	Uxbridge,	Cloth scour, rinse and dyes,	67,400	Mumford River,	River,	95
71	Uxbridge,	Cloth scour, rinse and dyes,	61,000	Mumford River,	River,	200
72	Uxbridge,	Cloth scour, rinse and dyes,	33,300	Blackstone River,	River,	130
73	Uxbridge,	Cloth scour, rinse and dyes,	41,600	Blackstone River,	River,	166
74	Uxbridge,	Cloth scour, rinse and dyes,	27,400	West River,	River,	125
75	Uxbridge,	Cloth scour, rinse and dyes,	48,000	Blackstone River,	River,	95
77	Millville,	Boiling and washing rubber,	-	Blackstone River,	River,	600
76	Millville,	Felt scour, rinse and dyes,	22,400	Blackstone River,	River,	120
78	Upton,	Dye and bleach liquors and wastes from Producer Gas Plant.	Large amount.	Tributary of West River,	Filtration area,	800
100	Upton,	Wash waters,	Small amount.	Tributary of West River,	Brook,	1
101	Upton,	None,	None.	- - -	- - -	1

Pollution of the Taunton River.

The Taunton River above the point where its tidal estuary joins Mount Hope Bay drains an area of about 512 square miles. The tide affects the flow of the river as far upstream as a point just above Taunton, 17 miles from the mouth of the river.

The drainage area includes a large part of Bristol and Plymouth counties and a considerable area in the southerly part of Norfolk County.

There is considerable storage within the watershed of the Taunton River which aids in maintaining the flow of the stream in dry weather, though the remarkable storage in the great Middleborough ponds in the southerly part of the watershed has in later years been greatly diminished by the diversion of water for water supply purposes by the cities of Taunton and New Bedford. The value of the storage within the watershed is considerably offset, however, by the great areas of swamps along the course of the main stream and many of its tributaries, which are a marked characteristic of this watershed, and which, while exerting a favorable effect in equalizing the flow of the stream in freshets, are undoubtedly the cause of a material loss to the flow of the stream in dry seasons on account of evaporation therefrom.

The watershed includes all, or the greater portion, of the following cities and towns, the population of which in census years since 1890 has been as follows: —

	1890.	1895.	1900.	1905.	1910.	1915.
Abington,	4,260	4,207	4,489	5,081	5,455	5,646
Avon,	1,384	1,626	1,741	1,901	2,013	2,164
Bridgewater,	4,249	4,686	5,806	6.754	7,688	9,381
Brockton,	27,294	33,165	40,063	47,794	56,878	62,288
Dighton,	1,889	1,797	1,802	2,070	2,235	2,499
East Bridgewater,	2,911	2,894	3,025	3,169	3,363	3,689
Easton,	4,493	4,452	4,837	4,909	5,139	5,064
Foxborough,	2,933	3,219	3,266	3,364	3,863	3,755
Freetown,	1,417	1,405	1,394	1,470	1,471	1,663
Halifax,	562	497	522	494	550	638
Hanson,	1,267	1,380	1,455	1,490	1,854	1,796
Lakeville,	935	870	958	912	1,141	1,491
Mansfield,	3,432	3,722	4,006	4,245	5,183	5,772
Middleborough,	6,065	6,689	6,885	6,888	8,214	8,631
Norton,	1,785	1,614	1,826	2,079	2,544	2,587
Plympton,	597	549	488	514	561	599
Raynham,	1,340	1,518	1,540	1,662	1,725	1,810
Somerset,	2,106	1,983	2,241	2,294	2,798	3,377
Taunton,	25,448	27,115	31,036	30,967	34,259	36,161
West Bridgewater,	1,917	1,747	1,711	2,006	2,231	2,741
Whitman,	4,441	5,744	6,155	6,521	7,292	7,520

The watershed also includes small portions of the cities and towns of Plainville, Wrentham, Norfolk, Sharon, Stoughton, Holbrook, Weymouth, Rockland, Carver, Pembroke, Rochester, Swansea, Rehoboth, Attleboro, North Attleborough and Fall River.

Of the cities and towns included in the foregoing table, Taunton, Brockton, Middleborough, Easton, Bridgewater, East Bridgewater, West Bridgewater, Abington, Whitman, Mansfield, Foxborough, Avon and Norton are provided with public water supplies, the water supply in most cases having been introduced many years ago.

Sewerage systems are in operation in Taunton, Brockton, Middleborough and Bridgewater, and in a very small area in the town of Foxborough, within the Taunton River watershed. In the remaining towns sewage is disposed of ordinarily into vaults and cesspools, which, while in many cases creating very serious local nuisances in the more thickly settled portions of these towns and villages, do not ordinarily cause the serious pollution of any of the streams.

Pollution of the Taunton River and its Tributaries by the Sewage of Cities and Towns.

The Taunton River and its tributaries are seriously polluted at many points by the discharge of sewage and manufacturing waste into the streams. As already stated, the tide affects the river as far as Taunton, and the flow of tidewater below the mouth of the Three Mile River adds very greatly to the volume of water available for dilution of polluting matters, so that below the mouth of the Three Mile River the effect of pollution is comparatively slight.

By far the most objectionable of all the pollution which the river receives is the sewage discharged from cities and towns. The most important of these pollutions is that caused by the sewage of the city of Taunton, which is discharged directly into the river, without treatment, below the city, and the sewage of the town of Middleborough, which is discharged into the Nemasket River, one of the principal tributaries of the Taunton. The sewage from sewers recently constructed in the town of Bridgewater is also discharged into the stream, and small quantities of sewage have at times in the past overflowed from the sewerage works of the city of Brockton into the Salisbury Plain River near the sewage pumping station of the city or into the Coweeset River, another tributary of the Taunton, adjacent to which the Brockton filter beds are located.

The city of Taunton was authorized by the State Board of Health in the year 1897 to discharge its sewage untreated into the Taunton River below that city, and this privilege was extended from time to time until in 1910 the time within which the discharge of sewage into the river could continue was limited by the Board to Dec. 1, 1913, and the city was required to prepare in the meantime plans for the proper disposal of the sewage. No decided action was taken by the city in regard to the order of the State Board of Health of 1910, but a petition was presented to the Board in 1914 for a further extension of time. The matter was subsequently taken up by the State Department of Health during the present year in response to a petition from the town of Dighton complaining of the pollution of the river, and after a hearing the Department took the following action with reference to the further disposal of sewage of the city of Taunton into the Taunton River: —

In response to a petition from the selectmen of the town of Dighton representing that the city of Taunton is discharging sewage into the Taunton River, notwithstanding the order of the State Board of Health made in 1910 to otherwise provide for its disposal, and also protesting against further pollution of the river and requesting immediate action to remedy the existing conditions, the State Department of Health gave a hearing to the town of Dighton and the city of Taunton, and other parties interested, at the City Hall in Taunton on Dec. 6, 1916.

After this hearing and after consideration of the records of the State Board of Health, the Department finds that the order of the State Board of Health dated Sept. 7, 1910, has not been complied with by the city of Taunton. It appearing, however, that the authorities of the city of Taunton are willing to proceed with the preparation of plans for an efficient system of disposal for the sewage of the city and to present them to the State Department of Health for its approval within three months from the date of the hearing, and that, further, the authorities of the city of Taunton propose to petition the Legislature of 1917 for authority to incur indebtedness to an amount which will be sufficient to enable the city to construct a satisfactory system of sewage disposal, this Department voted to continue the matter until March 6, 1917.

In the opinion of the Department, the sum of $75,000, mentioned at the hearing, would be quite inadequate for the construction of an efficient system of works for the disposal of the sewage of the city of Taunton. The Department recommends that an estimate be prepared at once of the probable cost of the construction of such works under the advice of an engineer of experience in matters relating to sewage disposal, and that this estimate be used as the basis of the proposed petition to the Legislature for authority to increase the borrowing capacity of the city for sewerage purposes. (Communication addressed to Board of Sewer Commissioners, Taunton, and dated Dec. 12, 1916.)

In view of the statements of the Taunton authorities, at the hearing referred to, that they would proceed at once to the construction of works for the removal and efficient treatment of the sewage of the city, the Department recommends that authority be given the city of Taunton at the present session of the Legislature to borrow the necessary funds to carry out this work.

Early in the year the town of Bridgewater presented a plan for disposing of the sewage of that town temporarily into the Town River, one of the principal tributaries of the Taunton River, but the plan, which provided for temporary discharge of the sewage into the river and subsequent partial treatment upon filter beds below the town, was not recommended by the Department. In the meantime the sewage is discharging into the river without treatment.

The town of Middleborough began the construction of sewerage works in 1885 before the passage of the laws relating to the prevention of the pollution of streams. The matter was brought to the attention of the Legislature by the State Board of Health many years ago, and shortly afterward the town proceeded to prepare plans for the collection and treatment of the sewage. These plans have not been carried out, and the objectionable pollution of the Nemasket River grows more serious from year to year.

At Brockton the entire sewage of the city, collected in a separate system of sewerage, is delivered at a reservoir and pumping station near the southerly boundary of the city, whence it is pumped to filters located in the valley of the Coweeset River, where, after filtration, the effluent is discharged into the river. In former times a considerable quantity of sewage was discharged into the Salisbury Plain River at the pumping station in periods of high flow in the sewers in the winter and spring and caused the serious pollution of that stream in the town of East Bridgewater. The overflow of sewage into this stream has since been discontinued. Sewage appears also to have been discharged at times into the Coweeset River in the neighborhood of the filtration area, but no such discharge has taken place recently, though the great quantity of effluent discharged into the river, the flow of which is small, has a very decided effect upon the chemical composition of the water in the stream.

In addition to the cities and towns having systems of sewerage, there are several public institutions within the watershed which produce considerable quantities of sewage, the largest being the State Farm at Bridgewater, which contains a population of inmates and officers amounting to 2,800. The sewage of these institutions was being cared for in a satisfactory manner at the time of the recent examination.

Pollution of the River by Sewage from Factories and Buildings along the Streams.

In addition to the pollution by sewage from cities and towns, the Taunton River and its tributaries receive considerable sewage pollution from other sources, chiefly factories along the stream and its tributaries. A careful examination of the various sources of pollution of this character shows that the sewage of about 10,800 persons is discharged into the stream in this way. The city and towns in which the principal portion of this discharge takes place are the following: —

Taunton,	4,086
Bridgewater,	2,469
Whitman,	1,705
Dighton,	815
Norton,	688
Mansfield,	533
Middleborough,	206
Easton,	153
Foxborough,	100
Other places,	45
	10,800

It will be seen that more than half of the sewage discharged into the river in this way is derived from the city of Taunton and town of Bridgewater, both of which have systems of sewerage. The discharge of sewage in this way at numerous places along the streams is objectionable and could in most cases be prevented by connecting the factories and other places from which sewage is so discharged with the general system of sewerage of the municipality.

The conditions at Whitman and Mansfield are such that it will be impracticable to prevent the pollution of the streams until these towns have provided themselves with systems of sewerage. It is probable, however, that at North Dighton, where the pollution is caused chiefly by factories and the population in the neighborhood is not large, the factories can provide separate means of disposal for their sewage, and the same is true in the case of some of the other pollutions mentioned in the list. At Norton, also, the sewage from individual plants can probably be cared for satisfactorily without the necessity of constructing as yet a sewerage system for the town.

Pollution by Manufacturing Waste.

In addition to the pollution of the Taunton River and its tributaries by sewage, these streams also receive considerable manufacturing waste. The manufacturing waste discharged into streams in this watershed is, as a rule, less objectionable than domestic sewage, since the latter not only contains great quantities of foul matter but also the germs of disease. Some of the manufacturing wastes, however, contain considerable quantities of organic matter which have a decided effect upon the condition of the streams into which they flow. The most objectionable of these wastes are those produced in the processes of scouring wool and washing cloth, and the wastes from laundries, gas works, leatherboard mills, and certain other establishments. Besides these are wastes from dyeing and bleaching, which, while having a noticeable effect upon the appearance of the streams, cause, as a rule, little serious pollution, and wastes from foundries, machine shops, power plants, etc., from which considerable acid, iron and oil find their way into the streams, affecting rather their appearance than the general condition of the water.

A description of the sources of pollution in the various cities and towns is here summarized: —

Three Mile River and Tributaries. — The most westerly tributary of the Taunton River is the Three Mile River, which joins with the Taunton at the extreme southerly boundary of the city. The Three Mile, with its two principal tributaries, the Wading and the Rumford rivers, drains the towns of Foxborough, Mansfield and Norton and the westerly part of the city of Taunton, including the villages of Oakland and Westville and the village of North Dighton in the town of Dighton.

In Foxborough, located at the head of the Rumford River, trade wastes are dicharged from three industrial establishments and domestic sewage from one establishment. The trade wastes consist of oil and waste from a producer gas plant, the waste water from a steam laundry, and the waste liquors from a hat works. At all of these works the waste is discharged into ditches close to the head waters of the river through which the wastes flow, with the result that considerable solid matter is settled out of the waste before it enters the stream. There is a small sewer system in this town which collects sewage from another hat works and several houses and discharges it upon land not far from a tributary of the Rumford River, where the sewage receives a certain amount of treatment before its final discharge to the stream.

At Mansfield six industrial plants are located along the Rumford River in its course through the town. Industrial wastes are discharged into the Rumford River from five plants and domestic sewage from three plants. The industrial wastes consist of a small amount of dyes from one leather shop, acid and potash liquors from a jewelry shop, general wash waters from a laundry, bleachery waste from a bleachery, and a small amount of oil and potash from a machine shop. The most objectionable of these wastes, aside from the domestic sewage, are those derived from the laundry, which amount to about 12,000 gallons per day, but the others have a noticeable effect upon the stream. It will be extremely difficult to prevent local nuisances and the continued serious pollution of the Rumford River in the village of Mansfield unless the town provides a system of sewerage.

At Norton manufacturing waste is discharged into the river from five mills and domestic sewage from six mills and from several houses. The plants causing pollution by industrial wastes consist of jewelry factories, a laundry, a bleachery and a wool-scouring plant. Domestic sewage is also discharged from all of these places and from a box shop, which does not cause other pollution of the river. The most serious pollution caused by any of these works, and one of the worst pollutions of any of the streams in the Taunton River watershed by manufacturing waste, is that caused by the wastes from a wool-scouring works which are located on the Rumford River a short distance below the Norton Reservoir. The total quantity of wool scoured at this works amounts to about 18,000,000 pounds per year, or about 60,000 pounds per day, and the waste, amounting to about a gallon of liquor per pound of wool, causes most serious pollution of the Rumford River. This establishment should be required to provide works for removing the grease from the wastes similar to those which have been provided by a number of other similar mills in the State, and the wastes, after being treated for the removal of grease, should be further treated for the removal of organic matter before their discharge into the stream. Next to the wool-scouring plant, the most objectionable pollution is caused by the laundry, and considerable pollution also results from the other factories, though its effect upon the river is much less than that of the works just mentioned. The wastes from the bleachery are very large in amount but contain comparatively little organic matter of a putrescible nature, while those from the jewelry factories are chiefly a small quantity of weak acids and potash liquors which have very little effect upon the river.

Within the limits of the city of Taunton, the Three Mile River receives pollution from a cotton cloth mill at Oakland, a cotton yarn mill at Westville, and a foundry and bleachery at North Dighton. At the Oakland mill a very small quantity of waste dye liquor is discharged into the stream, but the most important pollution is the discharge of sewage from the operatives, numbering about 100 at the time of the recent examination. At Westville the only pollution is that by sewage from operatives at a small mill at this location, the number of operatives at the time of the examination being 85. At North Dighton on the Taunton side of the river there are a foundry, from which a small quantity of acid escapes to the stream, and a bleachery, which discharges into the stream great quantities of water used in the processes of bleaching and dyeing, together with domestic sewage from a small number of operatives. The waste bleach and dye liquors from this establishment, while having a noticeable effect upon the appearance of the water at times, contain comparatively little organic matter of a putrescible nature, and, notwithstanding their great quantity, their effect upon the stream is not serious.

On the Dighton side of the river are two mills in the town of Dighton, — one, a small paper mill employing 15 hands, and the other, a bleachery of large size employing some 800 persons. The stock used in the paper mill is of such a character that there is very little waste therefrom, the waste coming chiefly from the paper machines and from the washing of the felt used on these machines. In consequence, the waste contains a small amount of organic matter as compared with that from an ordinary paper mill, but, as dyes are used, the discharge of this waste has at times a very noticeable effect upon this stream. At the bleachery a very great quantity of water is used in the various processes, the discharge amounting at the time of the recent examination to some 4,000,000 gallons per day. This discharge consists of bleach and dye liquors containing very little organic matter of a putrescible nature, and its chief effect upon the stream is that produced by the color. A far more objectionable pollution at the time of the recent examination was that caused by the discharge of the sewage of 800 operatives into the river.

Mill River and Tributaries. — The next important tributary of the Taunton River above the Three Mile is the Mill River and its principal tributary, the Canoe River, which drains parts of Foxborough, Mansfield, Easton and Norton above the city of Taunton. The Canoe River is polluted in Mansfield by the waste from a laundry and general sink drainage and domestic sewage from a chocolate mill. It receives very little pollution elsewhere until it enters the city of Taunton. In its course through that city it receives more or less domestic sewage from the eighteen sewer outlets along the river, from fourteen of which sewage was found to be discharging into the stream at the time of the recent examination. While the quantity of sewage usually discharged is not great in any particular case, the aggregate is considerable. The river also receives pollution from a number of private sewers and drains connected with the stream, including the sewage from several manufacturing plants.

Finally, the river is the place of disposal for the manufacturing waste from twenty-one of the thirty-four industrial establishments located along the stream. Domestic sewage from about 1,800 operatives in thirty of these establishments is discharged into the stream, and sewage from a population aggregating about 600 is also discharged into the river at other points through private outlets. The character of the manufacturing waste discharged into the stream is quite varied and consists of the wastes from the dyeing and bleaching of cotton goods, from scouring, carbonizing and dyeing wool and woolen rags, together with various acids used in plating metals, laundry wastes, and a small amount of miscellaneous trade wastes. The most serious pollution is that from the treatment of wool and woolen rags and from the laundries, and below the locations of such industries the river showed clearly the effect of the pollution it receives.

While an effort has been made to improve its condition in recent years, this river continues to be a most serious nuisance throughout the greater part of its length through the city.

Town River and Tributaries. — The next important tributary east of the Mill River is the Coweeset, Hockomock or Town River, which joins the Matfield River at Paper Mill Village in Bridgewater, forming the Taunton River proper. The Town River and its tributaries drain the more thickly settled portions of Easton, West Bridgewater and Bridgewater, and this river receives also the effluent from the sewage-disposal works of the city of Brockton.

The Coweeset River in the town of Easton was receiving very little pollution by manufacturing waste at the time of the recent examination, the chief pollutions consisting of small quantities of oil. The river receives considerable sewage from operatives in establishments along the streams in this town.

No important pollution of the Town River was found in West Bridgewater, but in Bridgewater the river is polluted considerably by wastes from a laundry, also small quantities of waste from one or two other establishments. The Town River receives a great amount of pollution from domestic sewage in Bridgewater, but very little at any point from manufacturing waste.

Matfield River and Tributaries. — East of the Town River comes the Matfield River and its two main tributaries, the Salisbury Plain River, which drains the city of Brockton and a large part of East Bridgewater, and the Satucket River, which drains the towns of Abington and Whitman and parts of the towns of Hanson and East Bridgewater.

The river at Brockton is polluted somewhat by manufacturing wastes, chiefly from a gas works, a laundry, a tack works, and a few other factories which discharge comparatively small quantities of waste into the stream. A filtration works for the wastes from the gas works is now being installed. The waste from a leatherboard mill, which formerly seriously polluted the stream, is now effectually cared for and the effect of the pollution has become insignificant. The principal pollution of the river from trade wastes, aside from the gas works, is that from the laundry, and this discharge could readily be prevented by connecting the laundry with the sewers. Formerly the Salisbury Plain River was the most seriously polluted by overflow from the Brockton sewage reservoir at the pumping station near the lower end of the city, a condition which caused much complaint in East Bridgewater. There has been no evidence of any overflow of sewage at this point during the past year.

The Satucket River at the time of the recent examination was receiving very little direct pollution. The Carver Cotton Gin Company has provided filter beds for the disposal of the sewage from its operatives, and the only sewage found entering the river was that overflowing from the cesspools at the tuberculosis sanatorium, where a small quantity of sewage was finding its way into the stream.

Wenatuxet River. — The Wenatuxet River, which enters the Taunton River from the east, flows through the towns of Plympton and Halifax and drains a very thinly settled region. No evidence of pollution of the stream was found in this watershed.

Nemasket River. — The Nemasket River, which also enters the Taunton River from the east, includes within its watershed the towns of Middleborough and Lakeville. This stream is very badly polluted by the sewage of Middleborough, which is discharged at two principal outlets opposite the town, and this stream receives also a small amount of pollution from private sewer outlets.

The principal pollution of the river by trade wastes at Middleborough is caused by a gas plant and a worsted mill. The wastes from the worsted mill are small in quantity but cause the discoloration of the river for a considerable distance below the mill. The wastes from the gas plant are very small in quantity and have little effect upon the stream.

Taunton River, Main Stream. — Besides the pollution discharged into its tributaries, the main Taunton River is badly polluted at several points. At Paper Mill Village, just below the junction of the Matfield and Town rivers, which unite to form the Taunton River at Bridgewater, is located a leatherboard mill, from which large quantities of highly colored wastes are discharged into the stream. These wastes are high in organic matter, though chiefly of a carbonaceous origin, and have a marked effect upon the condition of the stream for a considerable distance below the mill. There appears to be no good reason why these wastes should be allowed to discharge into the stream, since at other similar mills in this valley all wastes are utilized and kept out of the river.

Farther downstream, a short distance below the mouth of the Nemasket River, the sewage of the Bridgewater State Farm was formerly discharged into the stream through Saw Mill Brook. This sewage was being satisfactorily cared for at the time of the recent examination and the pollution of the stream prevented.

At East Taunton are located two cotton mills and an oilcloth factory, which discharge very little waste of any kind into the stream. The sewage from 835 operatives in the mills, however, is discharged into the stream without treatment.

Just above Taunton the river is joined by a small tributary from the north, which drains a considerable portion of the town of Raynham. In the valley of this tributary are several small industrial plants, some of which discharge very small quantities of trade waste into the stream. A small amount of domestic sewage also finds its way into this brook.

The chief pollution of the river at Taunton is that caused by the main sewer outlet, which discharges near the lower end of the thickly settled section of the city. There are also several other sewer outlets into the main river in this region, one or two of which are of considerable size. Trade wastes are also discharged into the stream in this region, the most important consisting of waste from the gas works, pickling and plating liquors from stove works, foundries and copper works, and oil from condensers. The quantity of manufacturing waste discharged into the river is comparatively small and its effect on the stream slight. Considerable domestic sewage is also discharged directly into the stream from the mills in this section of the city.

Cobb Brook, which enters the river a short distance below the Taunton sewer outlet, receives a small amount of pollution from domestic sewage.

General Condition of the Taunton River and its Tributaries as shown by Inspection and Chemical Analysis.

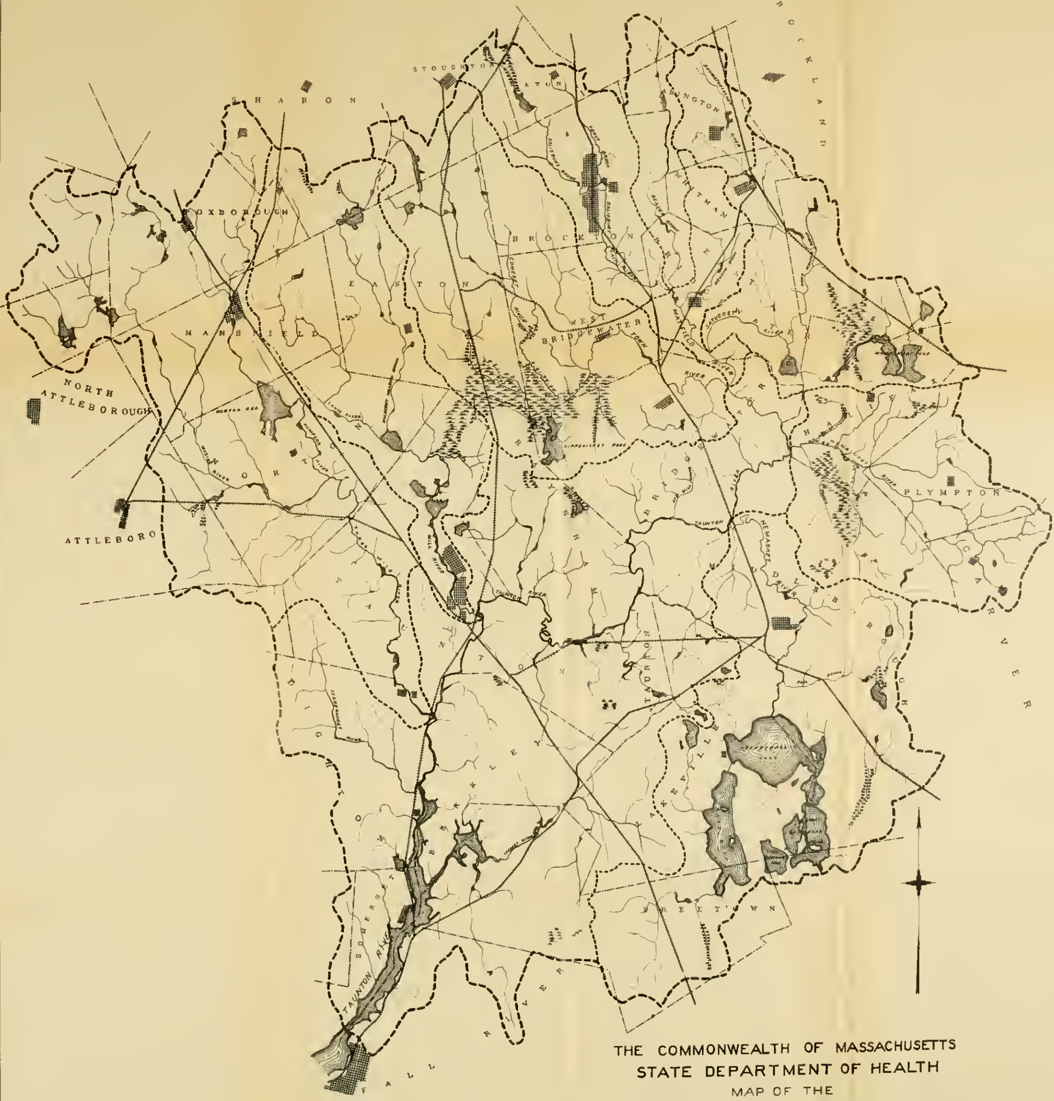
The main Taunton River below the confluence with the Town and Matfield rivers is polluted seriously by a leatherboard mill at Paper Mill Village, so called, but receives no other considerable pollution except by the sewage of the city of Taunton. Of the tributaries, the most seriously polluted is the Nemasket River, which receives the sewage of the town of Middleborough, and the Town River, which receives much sewage from Bridgewater. The discharge of sewage into the river at Brockton has been discontinued, but the effluent from the Brockton filtration works has considerable effect upon the condition of the Coweeset River in the immediate neighborhood of the filters, but the effect is chiefly on the chemical condition of the water.

Aside from these, the most seriously polluted tributary of the Taunton River, excepting the Mill River, is the Three Mile River, the condition of which has been found to be very objectionable for several miles below the wool-scouring mill at Norton. The river is also considerably polluted in Mansfield and receives a considerable amount of domestic sewage in several of the other villages.

Summary.

Of the four cities and towns within the Taunton River watershed which have thus far provided themselves with systems of sewerage, the city of Brockton alone has made adequate provision for the purification of its sewage, having spent a large sum for its disposal works, which involve also a very considerable annual outlay for maintenance and operation. The city of Taunton has now practically completed its sewerage system, has secured an area of land suited for sewage disposal, and is in a position to begin the construction of works. The town of Bridgewater has but just begun the construction of its sewerage system, which is not yet extended to considerable areas in the town, and the plans already prepared by the town include provision for the treatment of the sewage. The town of Middleborough, in which sewers were first built thirty years ago, or more, has taken no further step toward preventing the pollution of the Nemasket River than the preparation many years ago of a plan of sewage disposal.

In view of the fact that the city of Brockton is already doing its share to prevent the pollution of the river, and that the city of Taunton is preparing to expend a considerable sum for the purpose, it does not seem reasonable that the town of Middleborough should be allowed to continue longer the discharge of crude sewage directly into



THE COMMONWEALTH OF MASSACHUSETTS
STATE DEPARTMENT OF HEALTH
MAP OF THE

TAUNTON RIVER DRAINAGE AREA

SCALE IN MILES

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HELIOTYPE CO. BOSTON

the Nemasket River; and Bridgewater should also be required to treat its sewage, since its discharge into the Town River as now begun will inevitably create a nuisance.

It is also desirable that sewerage systems be provided in several of the towns in the watershed if further serious pollution of the streams is to be discontinued, especially in densely populated villages like Mansfield and Whitman, where considerable pollution of the local waters has become inevitable and will continue until a sewerage system is provided.

Pollution by manufacturing waste is serious as yet only in the Rumford River in Norton, including the Three Mile River, the Mill River in the city of Taunton and the main stream at Paper Mill Village. Provision should be made for the proper treatment of the wool-scouring wastes discharged into the Rumford River at Norton in order to prevent the gross pollution of this tributary and remove the very objectionable conditions existing there at the present time. The leatherboard wastes at Paper Mill Village can be cared for at the mill without serious difficulty, while the condition of the Mill River can be improved by discharging into the sewers the sewage and waste matters now flowing into the stream. This stream will, however, doubtless continue to be objectionable until a proper channel is provided.

Pollution of the Taunton River.

Reference Number.	Town.	Trade Waste Liquors.		Disposal of —		Number of Employees.[1]
		Kind.	Gallons per Day.	Trade Wastes.	Sewage.	
1	Taunton,	Bleach and dye liquors,	85,000	Mill River,	River,	1,150
2	Taunton,	General wash waters,	10,000	Mill River,	Sewer,	3
3	Taunton,	Acids, soap and rinse waters,	44,000	Mill River,	Sewer,	850
4	Taunton,	General wash waters,	11,000	Mill River,	River,	4
5	Taunton,	Mercerize, bleach and dye liquors,	106,000	Mill River,	Sewer and river,	(1) 300
6	Taunton,	None,	None.	- - -	River,	1
7	Taunton,	None,	None.	- - -	River,	4
8	Taunton,	None,	None.	- - -	Sewer and river,	(3) 80
9	Taunton,	None,	None.	- - -	River and vault,	107
10	Taunton,	Dyes,	112,000	Mill River,	River,	120
		Wash waters,	85,000			
10A	Taunton,	General sink drainage,	-	Mill River,	Privy,	9
10B	Taunton,	None,	None.	- - -	River,	12
11	Taunton,	Acids and rinse water,	Small amount.	Mill River,	Sewer,	-
		Wash water from barrels and vats,	Small amount.	Mill River,	River,	2
12	Taunton,	General wash waters,	38,000	Mill River,	River,	60
13	Taunton,	Oils and wash waters,	-	Mill River,	River,	5
14	Taunton,	Wash water on bottles and tubs,	-	Mill River,	River,	2
15	Taunton,	Acids, soap and rinse waters,	-	Mill River,	River,	60
16	Taunton,	Soaps, dyes and rinse water,	-	Mill River,	River,	4

16A	Taunton,	Small amount of dye liquor,	–	Mill River,	River,	2
17	Taunton,	Small amount of oil,	–	Mill River,	River,	100
17A	Taunton,	None,	None.	– – –	River,	9
18	Taunton,	None,	None.	– – –	River,	7
19	Taunton,	None,	None.	– – –	River,	3
20	Taunton,	None,	None.	– – –	River,	5
21	Taunton,	None,	None.	– – –	River,	15
22	Taunton,	Small amount of acid,	–	Mill River,	River,	3
		None,	None.	– – –	River,	38
		Acid, soap and rinse water,	–	Mill River,	River,	1
		None,	None.	– – –	River,	1
		None,	None.	– – –	River,	(2) –
23	Taunton,	Soaps, dyes and rinse water,	–	Mill River,	Vault,	7
24	Taunton,	None,	None.	– – –	– – –	–
25	Taunton,	Bleach liquors and starch,	9,000	Mill River,	River,	31
26	Taunton,	Acids, soap and rinse water,	Small amount.	Mill River,	River,	40
27	Taunton,	Bleach and dye liquors,	94,000	Three Mile River,	River,	35
28	Taunton,	Small amount of pickling liquor,	Small amount.	Three Mile River,	Cesspool,	–
29	Taunton,	None,	None.	– – –	River,	85
30	Taunton,	Dyes and rinse water,	210	Three Mile River,	River,	100
31	Taunton,	None,	None.	– – –	River,	(3) –
32	Taunton,	None,	None.	– – –	River,	80
33	Taunton,	Waste from ammonia and tar,	11,000	Taunton River,	River,	25

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[1] Figures in parentheses represent number of persons discharging sewage directly into stream.

Pollution of the Taunton River — Continued.

Reference Number.	Town.	Trade Waste Liquors.		Disposal of —		Number of Employees.[1]
		Kind.	Gallons per Day.	Trade Wastes.	Sewage.	
34	Taunton,	Condenser water,	–	Taunton River,	River,	9
35	Taunton,	Pickling liquors,	–	Cobb Brook,	Brook,	170
36	Taunton,	None,	None.	–	Sewer and brook,	(12) 80
37	Taunton,	None,	None.	–	Privies,	35
38	Taunton,	Acid liquors, etc.,	–	Sewer,	Sewer,	500
39	Taunton,	Acid liquors, etc.,	9,000	Taunton River,	River,	300
40	Taunton,	Plating and potash liquors,	300	Taunton River,	Sewer and river,	(3) 83
41	Taunton,	None,	None.	–	River,	80
42	Taunton,	None,	None.	–	River,	1
43	Taunton,	None,	None.	–	River,	6
44	Taunton,	Condenser water,	–	Taunton River,	River,	300
45	Taunton,	Condenser water,	–	Taunton River,	River,	100
46	Taunton,	None,	None.	–	Sewer,	150
47	Taunton,	None,	None.	–	River,	10
48	Taunton,	Condenser water,	–	Taunton River,	River,	285
49	Taunton,	Wash water, clay, etc.,	15	Taunton River,	River,	100
50	Taunton,	Condenser water,	–	Taunton River,	River,	450
51	Taunton,	Small amount of oil,	–	Cobb Brook,	River,	(125) 132
52	Taunton,	Wash after pickling,	–	Cobb Brook,	Sewer and river,	(15) –

53	Dighton,	Felt wash and paper machine waste.	72,000	Three Mile River,	River,	15
54	Dighton,	Bleach and dye liquors,	3,986,000	Three Mile River,	River	800
55	Norton,	Bleach liquors,	489,000	Wading River,	River,	120
56	Norton,	Potash, acid and plating liquors,	Small amount.	Wading River,	River,	80
57	Norton,	General wash waters,	33,000	Wading River,	River,	8
58	Norton,	Acids, etc.,	16,000	Wading River,	River,	275
59	Norton,	Oil from engine,	–	Wading River,	River,	30
60	Norton,	Wool scouring wastes,	54,400	Rumford River,	River,	175
61	Mansfield,	Wash from brushes,	–	Rumford River,	River,	6
62	Mansfield,	Potash and acid liquors,	12,000	Rumford River,	River,	100
63	Mansfield,	General wash waters,	11,700	Rumford River,	Privy,	3
64	Mansfield,	Slight amount,	–	Rumford River,	Privy,	3
65	Mansfield,	Oil, potash, etc.,	–	Rumford River,	River,	302
66	Mansfield,	Bleach liquors,	322,000	River via cinder bank,	Cesspool,	110
67	Mansfield,	General wash waters,	9,300	Canoe River,	Privy,	2
68	Mansfield,	Laundry, utensils and floor wash water.	29,000	Canoe River,	River,	125
69	Foxborough,	Bleach and dye liquors,	36,000	Rumford River,	River,	100
70	Foxborough,	Gas wastes (oil gas),	Small amount.	Rumford River,	Filters,	100
71	Foxborough,	General laundry,	12,500	Rumford River,	Privy,	32
72	Middleborough,	Overflow of gas scrubber,	13,000	Nemasket River,	River,	6
73	Middleborough,	Dyes, soap and wash water,	50,000	Nemasket River,	River,	200
75	Raynham,	None,	None.	– – –	Brook,	5
76	Raynham,	Small amount of water and paste,	–	Forge Pond Brook,	River,	10

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[1] Figures in parentheses represent number of persons discharging sewage directly into stream.

Pollution of the Taunton River — Concluded.

Reference Number.	Town.	Trade Waste Liquors.		Disposal of —		Number of Employees.[1]
		Kind.	Gallons per Day.[1]	Trade Wastes.	Sewage.	
77	Raynham,	None,	None.	- - -	Privy,	6
78	Raynham,	Dilute acid and lime mud,	60	Pine Swamp Brook,	Privy,	-
79	Bridgewater,	Wash water on brushes,	-	Town River,	Cesspool overflow to river,	1,700
80	Bridgewater,	Wash water on brushes,	-	Town River,	Cesspool overflow to river,	500
81	Bridgewater,	None,	None.	- - -	Urinals to river,	80
82	Bridgewater,	Pickling liquors,	Small amount.	Town River,	Privy,	80
83	Bridgewater,	None,	None.	- - -	River,	125
84	Bridgewater,	General wash waters,	12,300	Town River,	River,	3
85	Bridgewater,	Cooling and condenser water, with oil.	Large amount.	Town River,	Privy and river,	(6) 130
86	Bridgewater,	All water used over,	-	- - -	Privy,	18
87	Bridgewater,	Machine wastes,	347,000	Town River,	River,	55
88	East Bridgewater,	Small amount of oil,	-	Satucket River,	Filters,	355
89	Easton,	None,	None.	- - -	River,	3
90	Easton,	None,	None.	- - -	Cesspool and river,	45
92	Easton,	Small amount of oil,	-	Coweeset River,	Cesspool and river,	105
93	Easton,	Small amount of oil,	-	Coweeset River,	Privy,	-
94	Easton,	None,	None.	- - -	- - -	-
95	Brockton,	Water for soaking leather, small amount of oil.	-	Salisbury Plain River,	Sewer,	3,000
96	Brockton,	Filtered gas liquors,	21,000	Salisbury Plain River,	Sewer,	-
97	Brockton,	General laundry wastes,	26,000	Salisbury Brook,	Sewer,	40

98	Brockton,	Weak acid and lime sludge,	7,300	Salisbury Brook,	Sewer,	500
99	Brockton,	Slight amount of oil in cooling water.	Large amount.	Salisbury Brook,	Cesspool,	50
100	Brockton,	Slight leakage from tanks,	-	Trout Brook,	Sewer,	-
101	Brockton,	Weak acids and lime sludge,	4,000	Trout Brook,	Sewer,	11
102	Whitman,	General wash waters,	7,700	Poor Meadow Brook,	Privy,	10
103	Whitman,	Small amount of paste,	-	Poor Meadow Brook,	Brook,	24
104	Whitman,	Blacking, soak water,	-	Poor Meadow Brook,	Cesspool to brook,	675
105	Whitman,	Acids and lime mud,	420	Poor Meadow Brook,	Cesspool,	40
106	Whitman,	None,	None.	- - -	Brook,	5
107	Whitman,	None,	None.	- - -	Brook,	1
108	Whitman,	Blacking and soak water,	-	Poor Meadow Brook,	Cesspool and brook,	1,000
109	Abington,	None,	None.	- - -	River,	25
110	Abington,	Blacking and soak water,	-	Shumatuscacant River,	Cesspool,	250

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[1] Figures in parentheses represent number of persons discharging sewage directly into stream.

SPECIAL REPORT OF THE STATE DEPARTMENT OF HEALTH RELATIVE TO THE CONDITION OF HALE OR RIVER MEADOW BROOK IN THE CITY OF LOWELL.

To the General Court of Massachusetts.

The State Department of Health, having been authorized and directed by chapter 57 of the Resolves of the year 1916 to investigate the condition of Hale's or River Meadow Brook in the city of Lowell, presents the following report.

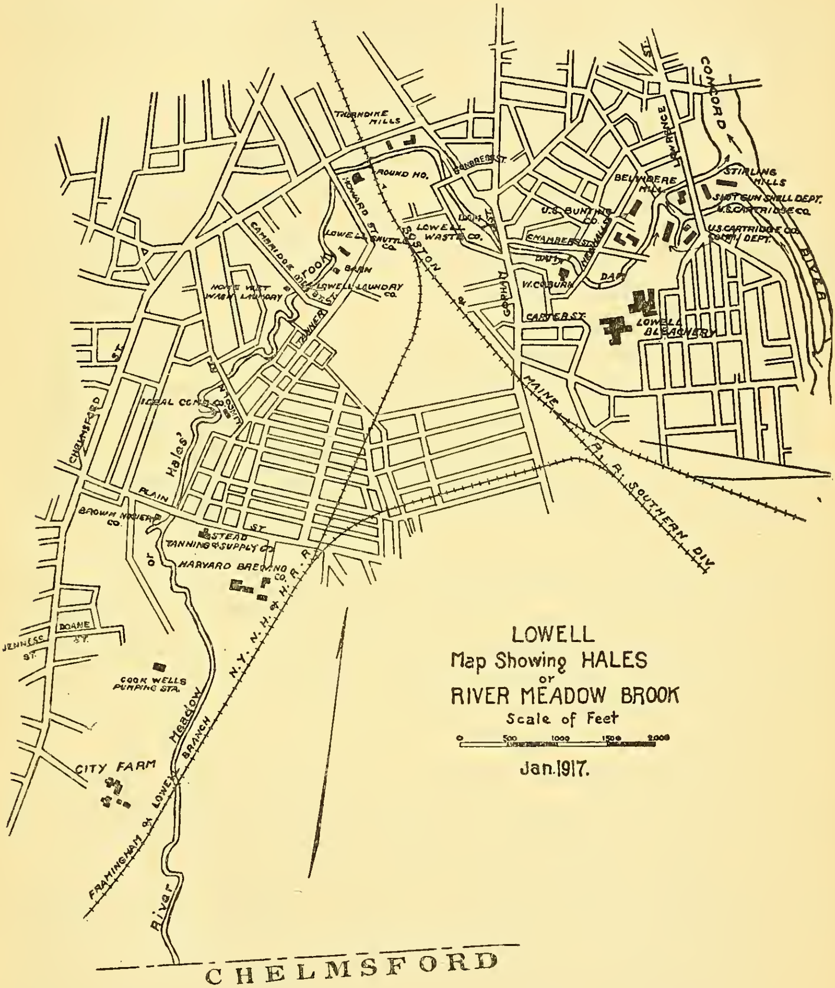
The resolve is as follows: —

> *Resolved*, that the state department of health is hereby authorized and directed to make an investigation of the brook known as the Hale or River Meadow brook in the city of Lowell with a view to improving the waters of the said brook in order to protect the health of the people residing in Gorham, Chamber and Newhall streets, and in other parts of the city adjacent to the river, and to report to the next general court not later than the tenth day of January.

Acting under this resolve, the Commissioner of Health has inspected the condition of Hale's Brook within the limits of the city of Lowell, and has caused the sources of pollution of the brook to be examined and samples of the waters of the stream to be analyzed.

Hale's or River Meadow Brook is a tributary of the Concord River from the west, entering that stream in the city of Lowell about a mile above its confluence with the Merrimack River. The brook at its mouth drains an area of 23.82 square miles, of which 1.97 miles are within the limits of the city of Lowell. The drainage area includes, besides a portion of Lowell, the southerly part of the town of Chelmsford and small portions of the towns of Westford, Carlisle and Billerica. The watershed above the point where the stream enters the city of Lowell is very sparsely populated, containing only the villages of Chelmsford Center and South Chelmsford. In the city of Lowell, however, it flows through a populous district for a little over a mile above its mouth. Along that part of the course of the stream from the neighborhood of Chelmsford Center practically to Cambridge Street in Lowell the river is bordered by meadows and flows with a sluggish current, especially in the lower portion of this section, where the height of water is controlled by a dam just above Gorham Street.

Between this point and the Concord River there are two other dams, and the stream has an aggregate fall between the dam just above Gorham Street and its mouth of about 26 feet in a distance of approximately 3,000 feet.



The river receives very little pollution above Plain Street in Lowell, one of the water supplies of the city of Lowell being located in this region. At Plain Street on the east bank of the stream there is a small tannery which discharges tannery wastes into the stream. The quantity was very small at the time the examination was made, amounting apparently on an average to about 400 gallons per day.

At the Ideal Comb Company's plant just above Lincoln Street water containing ashes used in polishing was being discharged into the river, but this material was free from organic matter. Between this point and the dam of the Lowell Waste Company little or no objectionable polluting matter enters the stream, though it receives a small amount of oil, chiefly from the yard and round-house of the Boston & Maine Railroad.

At Gorham Street a considerable amount of dust from the cleaning of cotton waste at the works of the Lowell Waste Company reaches the stream, but the first important pollution is found at the Lowell Bleachery, where at the time of this examination sewage from 500 employees and the waste liquors from bleaching about 400,000 pounds of cotton cloth per week were being discharged into the stream. This waste gave the stream a noticeable color, but no objectionable odor was found in this neighborhood.

Near Crosby Street is the plant of the United States Bunting Company, from which the sewage of 100 operatives and trade wastes in the form of wash waters after cloth scouring and stock dyeing were being discharged into the stream. The total quantity of trade waste was estimated at about 300,000 gallons per day and contained considerable dirt and fiber besides dye waste, which imparts a decided color to the stream.

At the works of the United States Cartridge Company near Lawrence Street sewage from nearly 450 operatives is discharged into the brook, and the stream also receives the wash water from the washing of shells amounting to a total of nearly 60,000 gallons per day. This waste appeared to cause little pollution, except that due to the presence of oil.

At the Stirling Mills, also located near Lawrence Street, sewage from 280 operatives, together with wool scouring and cloth washing wastes and dye liquors, was being discharged into the stream. The total quantity of the manufacturing waste at this mill is estimated to amount to about 270,000 gallons per day. This waste is discharged just above the point at which the stream enters the Concord River.

The results of this examination show, in general, that the sewage from about 1,300 operatives in mills was being discharged into Hale's Brook within the limits of the city of Lowell and is the most objectionable source of pollution of the stream. Next to the sewage, the most objectionable wastes are those discharged from the processes of wool scouring and cloth washing, and from certain of the processes carried on at the bleachery and at the works of the bunting company, all of these works being located near the mouth of the brook.

Samples of water were collected in the latter part of the year, at the time when the flow of streams was low, at various points along the brook in its course through the city of Lowell, and the results of these analyses are appended hereto. They show that the water of the stream receives but very little pollution above Newhall Street, and even at the Lawrence Street bridge near its mouth the quantity of organic matter present in the water was not excessive, but the appearance of the water in this region was objectionable at the time of the examination, partly on account of the color and partly on account of the presence of a large quantity of oil discharged into the stream in the manufacturing waste.

While the condition of the water of the brook is not objectionable, excepting in the region immediately above the Concord River, the appearance of the bed and banks of the stream is highly objectionable throughout the greater part of its course through the city of Lowell. especially in the region below Gorham Street. Much refuse, largely of an inorganic nature, is thrown or discharged into the stream, together with tin cans and other débris, and its shores are used as a dump in certain parts of the thickly settled districts of the city.

As a result of its investigation, the Department is of the opinion that the condition of the waters of Hale's Brook is not objectionable at present, excepting in the lower part of its course below the works of the Lowell Bleachery and the United States Bunting Company, and that the objectionable pollutions in this section of the river can easily be removed by the construction of proper sewerage facilities designed to receive both the sewage of operatives in these mills and those manufacturing wastes which are most seriously objectionable in their effect upon the stream. It will also be advisable, and will probably not be difficult, to provide suitable oil separators at the various establishments from which oil or grease now finds its way into the river. To remove the unsightliness of this stream, which is now its most objectionable characteristic, it will be necessary to provide a suitable channel, at least in the portion of its course below Gorham Street, in the places where the stream flows through populous districts. In other cities similar conditions have arisen and have been met by the construction of proper channels for the streams, examples of which may be found in Boston, Newton and elsewhere.

While the most objectionable conditions in the stream at the present time are found below Gorham Street, there is little doubt that with the growth of the city an improvement in the channel of the brook farther upstream will gradually be found necessary. Throughout the upper portion of its course through the city of Lowell, as already indicated, the stream is bordered by meadows which are overflowed at times of freshet, a condition which is not conducive to healthful conditions in the neighborhood of a large population. It is impracticable to advise without a proper survey as to the best method of improving the brook in this region or the probable cost of the necessary works, but, in the opinion of the Department, this portion of the stream should be included in any studies that may be made looking to an improvement of the channel of Hale's Brook.

Chemical Examination of Water from Hale's or River Meadow Brook, Lowell.

[Parts in 100,000.]

	Number.	Date of Collection.	Residue on Evaporation.		Ammonia.				Chlorine.	Oxygen consumed.
						Albuminoid.				
			Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
Above Plain Street, near Cook wells,	134424	Nov. 22, 1916	7.60	3.20	.0074	.0206	.0190	.0016	.60	.80
At Plain Street bridge,	134425	Nov. 22, 1916	6.80	2.20	.0082	.0210	.0198	.0012	.62	.80
At Lincoln Street bridge,	134426	Nov. 22, 1916	8.60	1.50	.0150	.0270	.0220	.0050	.72	.85
At Harvard Street bridge,	134427	Nov. 22, 1916	6.60	1.70	.0088	.0230	.0200	.0030	.59	.79
At Congress Street bridge,	134428	Nov. 22, 1916	7.20	2.10	.0110	.0220	.0198	.0022	.60	.77
At Newhall Street bridge,	134429	Nov. 22, 1916	8.00	3.20	.0106	.0222	.0190	.0032	.62	.78
At Lawrence Street bridge,	134430	Nov. 22, 1916	15.00	2.80	.0236	.0504	.0368	.0136	1.58	.71

REPORT ON INVESTIGATION OF NON-PULMONARY TUBERCULOSIS, AS PROVIDED BY CHAPTER 62 OF THE RESOLVES OF 1916.

The resolve calls for an investigation of the matter of non-pulmonary tuberculosis with special reference to children and adolescents throughout the Commonwealth. It directs the State Department of Health to determine so far as possible: —

First. — The present number of cases of non-pulmonary tuberculosis in the Commonwealth, and their situation.

Second. — The number of hospital beds now available for the care of such cases.

Third. — The number of additional hospital beds needed for the proper care and treatment of such cases, and the proper situation of such beds.

Fourth. — Whether such beds, if needed, should be supplied by additions to, or enlargements of, existing general or other hospitals, or by providing new institutions designed for the purpose of treating non-pulmonary tuberculosis cases exclusively.

Fifth. — How such additions to, or enlargements of, general or other hospitals, or such new institutions, if they are needed, should be financed and administered.

The subject of non-pulmonary tuberculosis is a very different one from that of pulmonary tuberculosis. The State Department of Health has placed pulmonary tuberculosis on the list of diseases to be reported, because, in their opinion, it is a communicable disease transmitted from person to person, causes the largest number of deaths of any one disease, and the person suffering therefrom is a danger to other persons around him and to the community in which he lives or travels unless proper precautions are taken. Non-pulmonary tuberculosis was placed on the reportable list that there might be figures at hand to show the ravages of the disease outside of the well-understood pulmonary form. The processes are usually slow and of comparatively little danger to other members of the family or to the community in which the patient lives.

In the pulmonary form, under which term tuberculosis of the entire respiratory tract should be included, hospitals are built and dispensaries are established, both for the care of the patient and the protection of the public. In the non-pulmonary form, whatever action is indicated by the terms of this resolve is practically for the treatment of the patient, in order that, so far as possible, the afflicted person may become a useful member of the community rather than a burden. It is seldom that there is any indication that these cases transmit the disease to others, as the bacilli are found in but very small numbers in the discharges from the lesions. They have become afflicted with the disease from having received the infective organisms into their system from some other source, probably through the digestive tract. Where the type of infection has been determined in these cases, a considerable number have been found to be bovine.

Non-pulmonary tuberculosis is found in various forms, but for convenience in discussing the needs of the cases it may be divided into the following groups, namely, meningeal, glandular, bones and joints, genito-urinary, visceral, skin.

The first, meningeal, is a very common form occurring mostly in young children. It runs an acute course, ends fatally, and no public provision for treatment and care seems necessary.

The second, glandular, is probably the most common form of all, although the reported cases and hospital records show a larger number of bone lesions.

A large proportion of the glandular cases lead useful lives, with little or no treatment outside of what they can obtain from their family physician. In one hospital in Boston, out of 6,503 patients admitted to the wards in 1915, 33 were admitted for treatment of enlarged glands. Of the cases recorded in the State Department of Health office, 27 per cent. belonged to this group. Patients in this group need good hygienic surroundings and good food with little other treatment. These cases could be treated in a hospital for truly incipient pulmonary cases, but ought not to be associated with open cases.

The third group, tuberculosis of the bones or joints, was found in 34 per cent. of the total cases reported. This is a group that needs both good hygienic surroundings and special treatment, if they are to have the best chance to become useful citizens; without it they are liable to become more or less crippled. Outside the largest centers, and to some extent there, the usual practice is to take these cases into a hospital and either operate on them and keep them in the hospital for an average of about three weeks, or put them in some special apparatus for a period of from three weeks to three months and then discharge them with more or less after-supervision.

The highest authorities state that these cases should have approximately two to three years to effect a permanent cure. The former course, however, is being taken in Massachusetts, partly because the cases are treated by the general surgeon, and partly because the hospitals are treating acute cases and do not wish to keep a patient in the wards the length of time these cases require. In recent years many of the private hospitals are providing special treatment for these cases.

The fourth group, genito-urinary tuberculosis, is found very largely in adult life. While it would in many cases be beneficial to have these cases under improved hygienic conditions for a longer period than can be expected in a general hospital, consideration of this class of cases is not called for in the resolve, as it refers to children and adolescents especially.

The fifth, visceral, may be considered with the preceding group.

The sixth group, skin tubercular cases, is not well reported and does not show up as it should even in hospital reports, but 40 cases being shown in a year in one hospital report, while the physician in charge of the department states he has 25 cases needing hsopitalization now. Here, again, special treatment is required as well as good hygienic surroundings.

Scope of Investigation.

In looking up data on non-pulmonary tuberculosis, we have communicated with 900 physicians, and received replies from only 108. Of these, 64 made the statement that they had treated no cases of non-pulmonary tuberculosis, while 44 reported they had treated cases and gave a list totalling 138. Of these 138 cases, 33 had been previously reported to their respective boards of health, and 105 had not been reported. Replies were also received from 14 hospitals in the State.

The State District Health Officers have been making systematic inspections of the hospitals in their respective districts this year, and have had in mind the various requirements of this resolve. From their investigations and observations, it has been possible to obtain much valuable information. A few hospitals outside the State have been visited, and the opinions of those who are doing work along the lines of this resolve have been consulted, as have those interested in tuberculosis of any form.

Although all forms of tuberculosis have been on the reportable list since 1907, it is an indisputable fact that non-pulmonary forms have been but poorly reported. This is clearly shown by the fact that only 822 cases of non-pulmonary tuberculosis were reported in 1915 in the State, 355 of these being in Boston, while the annual report of one of the Boston hospitals alone, for that year, showed a total of 678 cases treated.

In a comparatively small number of cases has it been practical to find the ages of the patients, but of those determined, 48 per cent. were children, 21 per cent. adolescents, and 31 per cent. adults.

Under the first determination of the resolve, — "the present number of cases of non-pulmonary tuberculosis in the Commonwealth, and their situation," — investigation has shown that the cases have been so poorly reported by the physicians generally and so seldom classified in their minds, that anything approaching accurate figures is impossible.

The figures obtained, however, show that the cases are fairly evenly distributed throughout the Commonwealth, 185 cities and towns having reported cases.

Under the second determination of the resolve, — "the number of hospital beds now available for the care of such cases," — investigation shows that the State sanatoria do not take such cases unless complicated with the pulmonary form. City institutions having tuberculosis hospitals seldom have beds kept exclusively for non-pulmonary cases, but frequently admit such cases with their other cases.

There are no private institutions having beds exclusively for non-pulmonary cases, but all admit them.

Under the third determination, — "the number of additional hospital beds needed for the proper care and treatment of such cases, and the proper situation of such beds," — as such cases are being treated at present, there is no waiting list, but certain institutional physicians claim they have been unable at times to place their patients where they would be under the most favorable conditions for recovery. Others claim they frequently have cases of this type complicated with the pulmonary form, for which they have neither adequate equipment nor specially trained staffs for their proper care and treatment. Additional beds in any place, without these requirements, would not benefit the cases specified in this resolve.

"The proper situation of such beds," — it is admitted by all authorities that fresh air, sunshine, rest, good food and proper hygienic conditions are necessary factors in restoring this type of patients as near as possible to normal conditions and efficiency.

The question of whether these cases do better at the seaside or at higher altitudes still has strong advocates on each side, and still seems far from being conclusively settled. Those doing special work in this type of cases in private and municipal hospitals in New York, New Jersey and Pennsylvania generally advocate the seaside.

We believe that situation in the mountains or at the seashore is a consideration secondary to that of adequate equipment and specially trained staffs above mentioned, and that these cases will do well in either place if they are supplied with the above requirements.

Under the fourth determination, — "whether such additional beds. if needed, should be supplied by additions to, or enlargements of, existing general or other hospitals, or by providing new institutions designed for the purpose of treating non-pulmonary cases exclusively," — it is our opinion that, for the present at least, it would be best to provide the needed beds at existing institutions which are already equipped and doing excellent work along these lines, but are not run exclusively for non-pulmonary tuberculosis. We refer to the Massachusetts Hospital School for the care and education of crippled and deformed children at Canton, and, if they cannot care for all, the corporation of Hospital Cottages for Children at Baldwinsville.

The former is a State institution, built for 300 beds. In 1915 it had an average of 262 patients, about one-third of whom were cases of tubercular bone lesions.

The institution at Baldwinsville is supported by private funds, but has five trustees appointed by the Governor and Council.

At present it does not seem necessary to provide new institutions for the purpose of treating the type of cases referred to in the resolve.

Under the fifth determination, — "how such additions to, or enlargements of, general or other hospitals, or such new institutions, if they are needed, should be financed and administered."

In the event of the utilization of the institutions above-named, it would not be necessary to further amend chapter 446, Acts of 1904, as amended by chapter 226, Acts of 1907, or chapter 497, Acts of 1909, or any other acts, if any, applicable thereto, in order that the necessary additions to or enlargements of the same may be made, and their scope broadened or extended so as to provide for the needs, care and treatment of the type of cases under consideration in this resolve. At the Hospital Cottages for Children at Baldwinsville a fixed charity rate already exists for cases supported by the State, or any city or town within the Commonwealth.

The financing and administration of such institutions would be an easily solved problem. The Hospital School at Canton is a State institution. No special legislation would be required except the additional necessary appropriation.

The corporation of the Hospital Cottages for Children at Baldwinsville, in the event of its being necessary to increase the bed capacity of the institution, might require some further agreement.

CONCLUSIONS.

1. The actual need for special institutions for the treatment of cases of non-pulmonary tuberculosis is not at present recognized by the majority of the medical profession.

2. General use has not been made of the already available beds in existing institutions.

3. Within the next two years, the number of available beds for pulmonary tuberculosis cases will be increased by over 900 beds, when the cities of over 50,000 population carry out their contemplated plans, and the county commissioners discharge the duties imposed upon them by the Legislature of 1916. The completion of these hospitals should give the opportunity so much needed for the segregation of different classes of tuberculosis cases in the various private, municipal and State sanatoria, which segregation may have some bearing on this subject.

4. The Hospital School at Canton, and, to a limited extent, the Hospital Cottages at Baldwinsville are already organized, equipped, and at work with good results along lines most needed by the non-pulmonary tuberculosis cases. By extending their work the present needs for the care of non-pulmonary cases can be met.

5. Until such time as the whole work for tuberculosis cases in general has adjusted itself to the increased facilities that the next two years will furnish, it would not be advisable to consider the building and organizing of any new institution for the non-pulmonary tuberculosis cases.

RECOMMENDATIONS.

Such amounts as it may be deemed wise to appropriate for the proper care and treatment of non-pulmonary cases of tuberculosis should be disbursed through the trustees of the Massachusetts Hospital School and the State Board of Charity, because the subject is one for the care and treatment of children already diseased rather than for the prevention of disease.

PROPOSED LEGISLATION.

Only such legislation as may be necessary to authorize the trustees of the Massachusetts Hospital School to change their rules and regulations so as to properly care for and treat children and adolescents suffering from non-pulmonary forms of tuberculosis should be proposed.

REPORT OF THE STATE DEPARTMENT OF HEALTH, AS AUTHORIZED AND DIRECTED UNDER THE PROVISIONS OF CHAPTER 136 OF THE RESOLVES OF THE YEAR 1915, RELATIVE TO AN INVESTIGATION WITH REFERENCE TO THE ADVISABILITY OF ESTABLISHING COUNTY OR DISTRICT HOSPITALS FOR THE CARE AND TREATMENT OF CASES OF TUBERCULOSIS, FROM CITIES AND TOWNS HAVING LESS THAN 50,000 INHABITANTS.

To the Honorable Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The State Department of Health, in accordance with and under the provisions of chapter 136 of the Resolves of the year 1915, was "authorized and directed to investigate as to the advisability of establishing county or district tuberculosis hospitals for the care and treatment of cases of tuberculosis from cities and towns having less than fifty thousand inhabitants," and to "report the result of its investigation to the general court with such recommendations for legislation as it may consider advisable." The resolve, chapter 136 of 1915, is as follows: —

RESOLVE PROVIDING FOR AN INVESTIGATION AND A REPORT BY THE STATE DEPARTMENT OF HEALTH AS TO THE ADVISABILITY OF ESTABLISHING COUNTY OR DISTRICT TUBERCULOSIS HOSPITALS.

Resolved, That the state department of health be authorized and directed to investigate with reference to the advisability of establishing county or district hospitals for the care and treatment of cases of tuberculosis, from cities and towns having less than fifty thousand inhabitants. Said department shall report the result of its investigation to the next general court on or before the second Wednesday in January, and shall accompany its report with such recommendations for legislation as it may consider to be advisable. [*Approved May 28, 1915.*

Under the authority, and as directed thereby, the Department has made numerous investigations and studies of tuberculosis and the hospital problems connected therewith, both within and without the Commonwealth, including municipal, county, State, national and international reports and findings concerning the subject. In connection with this investigation the Department examined and consulted various other reports, records, statistics, vital and otherwise, for the purpose of determining for those communities not already served the need of hospitalization for cases of this disease. While the Department has been diligent in this work, the scope of the subject-reference implied in the resolve has been so great as to continually broaden and open up, more and more, the retrospective, present and prospective consideration of this the most important of all communicable diseases the world over. Whenever, as has been the experience of the Department, the subject of "tuberculosis" has been viewed and reviewed from the standpoint of those authorities most familiar with its ravages, there has been but one general opinion as to the necessity of adequate care for those so afflicted, namely, additional hospital provisions to meet the individual case needs, and thus further safeguard and protect the public health not only of the present but of the future generations. The need as well as the expediency of additional consumptive hospital provision in the Commonwealth is, in the opinion of this Department, so overwhelmingly clear as to admit of no debate. The only problem that remains is as to the type and number of institutions that will best fit the needs of the State at large. For years it has been obvious, as a matter of public health administration, that the smaller communities should not be called upon to finance alone the construction and maintenance of tuberculosis hospitals for the care of consumptives. That the General Court clearly appreciates this fact is self-evident from the very language of the resolve. All the problems involved under the terms of the resolve have been covered as thoroughly as time and circumstances permitted. For convenience of reference we have divided the report under the following headings: —

I. General conclusions.
II. The problem.
    A. The size of the problem.
    B. Provisions already made by the Commonwealth for hospitalization of consumptives.
    C. Provisions already made by municipalities in excess of 50,000 population.
    D. Provisions already made by municipalities under 50,000 population.
    E. Extent to which other agencies than as above stated are supplying the hospital needs for consumption.

III. Solutions of the problem.
    A. By the State assuming the entire responsibility for tuberculosis hospitalization.
    B. By separate municipalities and towns.
    C. By leaving present conditions as they exist.
    D. By evolving a new, comprehensive and uniform standard of procedure to supplement gaps in the plan of existing hospital provisions.
IV. Legislation recommended.
V. Appendix.
    A. Statistics on hospitalization of consumptives.

I. General Conclusions.

1. Pulmonary tuberculosis or consumption, universally conceded to be a preventable disease, is to-day responsible for more deaths than any other communicable disease within this Commonwealth.

2. The prevalence and fatality of consumption are steadily decreasing in the State of Massachusetts at the present time.

3. The present system of hospitalization for consumptives, although very incomplete, appears to be one of the greatest factors in this decrease.

4. Facilities for hospitalization of consumptives in this Commonwealth are to-day approximately two-thirds complete.

5. If the State sanatoria could be utilized exclusively for the treatment of early and favorable cases, the present facilities for sanatorium treatment of early consumption are adequate.

6. There is at the present time no sharply drawn line of distinction between the function of the State sanatoria and the municipal or local tuberculosis hospitals.

7. From the standpoints of public health, public need, humanity and good business administration, the municipally supported hospital for consumptives has proved the best solution of the consumptive hospitalization problem for large cities.

8. From the same standpoints the individual local tuberculosis hospital for the small community fails to fit the needs of such communities.

9. Therefore it becomes a paramount duty of the Commonwealth, through appropriate action of the General Court, to make such provision for the consumptive hospital needs of smaller communities throughout the Commonwealth as will adequately solve the local consumptive hospitalization needs of each and every community in the Commonwealth.

10. The county or district consumptive hospital so planned as to provide an efficient unit of administration without imposing the burden

of excessive cost or of unreasonable difficulty of access upon citizens of every community served thereby is the only practical type of institution that will meet the needs of the situation.

II. The Problem.

A. *The Size of the Problem.*

It has been stated in previous legislative reports of investigations that consumption in Massachusetts is a disease of 40,000 people. It has also been stated in previous reports that the number of consumptives needing hospital care is from 10,000 to 15,000.

In the light of past experience, both within this Commonwealth and other sections of the civilized world, as to relationship between total number of tuberculosis infections and the number of beds needed for hospital care, we believe the latter estimate is unquestionably far too high. Various methods have been used to determine the existing number of tuberculosis cases. They have ranged all the way from a ratio of 6 to 20 cases to every 1 death.

The accuracy or fairness of all these methods of computing the total prevalence of tuberculosis infection becomes more or less of mere academic interest from the practical standpoint of determining hospital facilities needed. Actual experience of many localities has shown that other methods of estimation will approximate quite closely to the needs of tuberculosis hospitalization as determined by experience. Generally speaking there are two widely accepted methods of estimating the consumptive hospitalization needs of any community. One calculation is based on supplying a consumptive hospital bed for every thousand of population; the other is based upon the principle of supplying one bed for every death per annum from consumption. Both methods are open to serious sources of error when applied to individual communities, depending largely upon such factors as concentration of population, industrial character of the population, the extent to which local tuberculosis deaths are influenced by outside importations into tuberculosis institutions, the age distribution of population, housing conditions, and many other factors. However, for large and diversified units of population either method of computation will give results that approximate each other to an astonishing degree, and also give a basis of estimation that proves to be very close to the actual number of beds that have been found to satisfactorily solve the local tuberculosis hospital question in certain large urban units of population. On this basis, exclusive of the beds for incipient pulmonary tuberculosis and for the non-pulmonary type of tuberculosis, a total bed capacity for advanced and moderately advanced consumptives of approximately 3,600 to 4,000 beds would adequately solve the consumptive hospital problem for the Commonwealth. There already are 3,165 tuberculosis beds, but of these, 1,068 are in the State sanatoria that are designed primarily for incipient cases. This leaves 2,097 beds other than those in the State sanatoria. Assuming that 3,600 to 4,000 beds would provide adequate hospital provision for consumptives, aside from the facilities of the State sanatoria, this would indicate that we have approximately one-half enough total beds at the present time for complete hospitalization of advanced consumptives.

B. *Provisions already made by the Commonwealth for Hospitalization of Consumptives.*

The State Board of Insanity at the present time provides special tuberculosis ward care for the tuberculous insane, and they have been left out of the computation throughout this report.

For the non-insane the State, at the present time, provides 1,528 beds, distributed as follows: —

Rutland State Sanatorium,	350
Lakeville State Sanatorium,	268
North Reading State Sanatorium,	200
Westfield State Sanatorium,	250
Prison Camp at Rutland,	100
State Farm, Bridgewater,	20
State Infirmary wards,	340
	1,528

Of this total number approximately 150 are beds for tuberculosis in children, some of which are and some of which are not pulmonary. The 100 beds at the Prison Camp and the 20 beds at Bridgewater apparently are adequate for the needs of consumptives in penal institutions, according to the reports of authorities in charge of the same. The tuberculosis beds at Tewksbury are open to all stages of consumption, but the cases are practically all of the far advanced type. This institution does not at present by any means provide adequate hospital facilities for all of the consumptives that are State charges or that do not possess a legal residence in any city or town in the Commonwealth. If the policy of the Commonwealth should be to endeavor to place all consumptives who are also State charges in the institution at Tewksbury, the bed capacity at this place is seriously inadequate, but whether such a policy should be instituted is at least an open question.

In recent years it has been the policy of the Trustees of Hospitals for Consumptives and the State Board and Department of Health — and past General Courts have set the seal of their approval on this policy — that the State sanatoria should be devoted entirely to the so-called incipient, early or favorable case of consumption. Under present conditions, with the tremendous pressure for bed accommodation, owing to the lack of adequate local tuberculosis hospital facilities, none of the State sanatoria even remotely measure up to this ideal. According to the most reliable information that this Department can obtain, on the average not over 25 per cent. of the present inmates of the State sanatoria can be properly classed as incipient cases.

C. *Provisions already made for Hospitalization of Consumptives by Cities of 50,000 or More Inhabitants.*

The total number of beds already provided for consumptives by the larger municipalities, or available for consumptives residing therein, through the generosity of private philanthropists or charitable organizations, are in all 1,176 beds. In the total list of 12 cities which come under the 50,000 classification there are but 3, according to the methods of estimation pursued, that already are providing adequate hospital facilities for consumptives. These cities are Cambridge, Lawrence and New Bedford. Estimates of the number of additional beds needed to furnish adequate hospital facilities for consumptives in the individual cities vary materially with the different methods of computation employed, the number of beds needed varying more than 100 per cent.; but such estimates of the number of beds needed by this group of cities as a whole, based upon an average of three accepted methods of computation, indicate that approximately 750 additional tuberculosis beds are needed to adequately hospitalize the consumptives of this group of cities.

Experience has shown in this Commonwealth as elsewhere that provision for the same number of beds for males and females is a serious mistake in tuberculosis hospital construction. The number of male applicants is always from 25 to 50 per cent. greater than of female applicants. Thus in planning additional beds this fact should be considered.

D. *Provisions already made for Hospitalization of Consumptives by Municipalities and Towns under 50,000 Population.*

Aside from the provisions made by the Commonwealth itself, the total number of beds provided by cities and towns of under 50,000 population at present throughout the Commonwealth is 155 beds.

There are 66 additional beds maintained by private philanthropy, but which are in effect institutions maintained for the exclusive benefit of the cities or towns in which they are located. These two groups together provide for the smaller cities and towns a total of 221 beds.

According to the State census of 1915 the total population of the Commonwealth is 3,693,310. The total population of the group of cities of over 50,000 inhabitants is 1,857,286, and the population for the rest of the State is 1,836,024. Thus on a basis of population alone the tuberculosis hospital needs of these two groups of communities would appear to be almost identical. Because of the higher rate of prevalence of tuberculosis in the larger communities there is no question that proportionally there is need of a larger number of tuberculosis beds to adequately solve the tuberculosis problem in such communities than for the remaining cities and towns of the State also considered as a distinct group.

The fatality from consumption in the group of cities and towns under 50,000 is about one-fifth less than that of the cities of over 50,000 population. Estimates as to the discrepancy in tuberculosis hospital needs, based upon this difference in actual consumptive death rates between these two groups, indicate that whereas approximately 2,000 beds are needed to supply adequate hospital provision for the group of cities of over 50,000 inhabitants, only about 1,600 are needed to as adequately furnish hospital provision for the remainder of the State. As above stated, the cities of over 50,000 inhabitants now have 1,176 beds available, which number is inadequate by fully 750 beds. For the cities and towns having less than 50,000 inhabitants there already exists for the entire group only 221 available beds. In other words, there is a deficiency of approximately 1,400 beds for this group of communities, which is twice as great a deficiency as for the cities of 50,000 and more inhabitants. This fact alone indicates the need of solving the tuberculosis hospital problem for the smaller communities.

E. *Other Agencies for supplying Hospital Needs for Consumptives in the Commonwealth.*

Aside from the bed provision made by the Commonwealth itself, and by the cities and towns or by private organizations for the benefit of certain cities and towns, there are in the State a certain number of beds which practically serve more than a local community; these are mostly private paying sanatoria. The total number of such beds, 165, is so small as not to be a factor of any consequence in the general tuberculosis hospital problem of the State.

III. SOLUTIONS OF THE PROBLEM.

A. *By the State assuming Entire Responsibility for Tuberculosis Hospitalization.*

While this might be a good business proposition, financially considered it would introduce an additional problem, namely, what should be done with already existing city and town institutions, hospitals, etc. For example, should the existing city and town hospitals or institutions be continued or discontinued? Should they be added to or otherwise enlarged? Should they all be purchased outright by the Commonwealth? In other words, what relationship would such city and town hospitals or institutions bear to the State's assumption of entire responsibility therefor?

The best answer to this suggested solution of the problem is the unwillingness of cities and towns to give up what they now possess and enter into agreements with State institutions, or have the State take from them the rights conferred by previous legislation relative to caring for their own cases of tuberculosis. It would also tend to a loss of local sympathy and interest in both institution and patient. It would create a gap constantly widening, and finally divorce the local relationship between the patient and the institution which should be fostered rather than lost. In theory this solution of the problem is appealing, but in practice impossible.

B. *By Separate Municipalities and Towns.*

This would only add to the problem instead of aiding in its solution. The number of beds that exist already would have to be increased. This would entail excessive overhead expenses and would impose heavy burdens upon small communities, entailing excessive rates of taxation for indefinite periods of time. Comparatively few cities and towns have been able to live up to or meet the needs of hospitalization for their own cases. In fact, certain cities have found it impossible to adequately care for cases needing city and town hospitalization, and have been forced to send their own cases to various more or less remote hospitals and institutions, away from both relatives and friends.

This solution of the problem, like the one first considered, will prove impracticable, and, as in the past, a failure.

C. *By leaving Present Conditions as they exist.*

This solution offers nothing by way of relief for cases of tuberculosis. To accept this solution is to allow the tuberculosis situation to remain where it is, and points nowhere except backward. It offers nothing for the relief of the patient and exposes the family and friends of the patient to constant sources of infection. This would manifestly be a step backward rather than forward in the city and town care and treatment for such unfortunates. It would show to the people of this Commonwealth that some form of paralysis, economic or otherwise, had seized the public, and so stifle all attempts to settle the problem.

D. *By evolving a New Comprehensive and Uniform Standard of Procedure to supplement Gaps in Existing Hospital Provisions.*

This offers the opportunity of a new standard, both comprehensive and uniform, for the care and treatment of consumptives, by providing a logical solution of the problem. It furnishes a basis for continuity of effort in the plan of hospital provisions; thus by this plan there will be furnished State hospital provision, county hospital provision and municipal hospital provision; the county hospital provision to meet the needs of the smaller cities and towns and to give them the same standard of service offered by the State and larger municipalities. In other words, a three-link chain of service instead of two.

The county unit appears to this Department the only logical means for providing State-wide tuberculosis hospital facilities for consumptives for towns and cities of less than 50,000 population, not already provided for under the laws of the State. In these communities there is a distinct need of hospitals for consumptives which neither the State nor municipalities have met thus far. Such a county plan should be based on a minimum bed provision of one bed to each death from tuberculosis, as outlined elsewhere in this report. With this general principle firmly established, it is the opinion of this Department that the details of procedure should be properly left to the authorities who are charged with the responsibility of providing such hospital care, rather than to attempt to regulate by statute the individual needs of each community, and the accompanying legislation has been drafted with this object in view.

Respectfully,

A. J. McLAUGHLIN,
Commissioner of Health,
For the Public Health Council.

IV. APPENDIX.

Statistics of Hospitalization of Consumptives.

Beds for Consumptives, by Counties.

[A, State institutions. B, Private institutions having other than local patronage. C, Essentially local tuberculosis institutions either publicly or privately owned.]

	Total Beds.	A.	B.	C.
Barnstable County,	-	-	-	-
Berkshire County,	22	-	-	-
Pittsfield Anti-Tuberculosis Hospital,	-	-	-	22
Bristol County,	146	-	-	-
Fall River City Hospital and Bay View Hospital,	-	-	-	60
New Bedford Tuberculosis Sanatorium,	-	-	-	86
Dukes County,	-	-	-	-
Essex County,	200	-	-	-
Haverhill Tuberculosis Hospital,	-	-	-	22
Lawrence Tuberculosis Hospital,	-	-	-	88
Lynn Tuberculosis Sanatorium,	-	-	-	60
Salem Contagious Hospital,	-	-	-	30
Franklin County,	-	-	-	-
Hampden County,	317	-	-	-
Chicopee Health Department Hospital,	-	-	-	14
Holyoke Sanatorium,	-	-	-	27
Springfield Health Department Hospital,	-	-	-	26
Westfield State Sanatorium,	-	250	-	-
Hampshire County,	40	-	-	-
Hampshire County Sanatorium,	-	-	-	40
Middlesex County,	777	-	-	-
Cambridge Tuberculosis Hospital,	-	-	-	110
Cambridge, Holy Ghost Hospital,	-	-	65	-
Everett Tuberculosis Hospital,	-	-	-	24
North Reading Sanatorium,	-	200	-	-
Somerville Contagious Hospital,	-	-	-	20
Tewksbury State Infirmary,	-	340	-	-
Waltham Hospital,	-	-	-	18
Nantucket County,	-	-	-	-
Norfolk County,	38	-	-	-
Brookline Tuberculosis Hospital,	-	-	-	14
Sharon Sanatorium,	-	-	24	-

Beds for Consumptives, by Counties — Concluded.

	Total Beds.	A.	B.	C.
Plymouth County,	323	–	–	–
Bridgewater State Hospital,	–	20	–	–
East Bridgewater, Millet Sanatorium,	–	–	35	–
Lakeville State Sanatorium,	–	268	–	–
Suffolk County,	644	–	–	–
Boston Consumptives' Hospital,	–	–	–	403
Dorchester Free Home for Consumptives,	–	–	–	30
Cullis Home for Advanced Consumptives,	–	–	–	40
House of the Good Samaritan,	–	–	–	17
Channing Home,	–	–	–	22
Prendergast Camp,	–	–	–	14
St. Monica's Home (colored women),	–	–	–	20
Long Island Hospital,	–	–	–	90
Chelsea, Soldiers' Home,	–	–	8	–
Worcester County,	658	–	–	–
Clinton, Carter Memorial,	–	–	–	26
Fitchburg Tuberculosis Hospital,	–	–	–	29
Lunenburg, Hillcroft,	–	–	7	–
Rutland State Sanatorium,	–	350	–	–
Rutland Cottages,	–	–	91	–
Prison Camp, Rutland,	–	100	–	–
Worcester Tuberculosis Hospital,	–	–	–	55
	3,165	1,528	230	1,407

Table I. — *Average Deaths per Year from Pulmonary Tuberculosis in Massachusetts, by Counties (1910–14 inclusive).*

Counties.	Population, 1915.	Annual Average (1910-14).
Barnstable,	28,818	22.2
Berkshire,	114,709	95.6
Bristol,	346,964	399.0
Dukes,	4,904	2.4
Essex,[1]	463,662	471.2
Franklin,	48,256	30.4
Hampden,[1]	262,944	293.6
Hampshire,	69,549	63.2
Middlesex,[1]	733,624	984.4
Nantucket,	3,166	2.2
Norfolk,	201,907	161.6
Plymouth,[1]	151,303	202.0
Suffolk,	826,801	1,111.2
Worcester,[1]	430,703	457.8
	3,693,310	-

[1] Including deaths in State tuberculosis institutions.

TABLE IA. — *Estimated Additional Consumptives Hospital Provision needed in the Various Counties of the Commonwealth.*

COUNTIES.	Actual Number of Beds.[1]	Additional Beds needed by Method A.[2]	Additional Beds needed by Method B.[2]	Additional Beds needed by Method C.[2]	Additional Beds needed by Method D.[2]
Barnstable,[3]	–	29	22	30[4]	18
Berkshire,[3]	22	93	74	80	50
Bristol,	146	201	253	150	125
Dukes,[3]	–	5	2	–[4]	3
Essex,	200	264	271	200	163
Franklin,[3]	–	–[5]	–[5]	–[5]	–[5]
Hampden,	67	196	169[6]	200	139
Hampshire,[3]	40	78[5]	53[5]	40[5]	33[5]
Middlesex,	172	562	548[6]	450	402
Nantucket,[3]	–	3	2	–[4]	2
Norfolk,[3]	14	188	148	150	112
Plymouth,	–	151	130[6]	125	118
Suffolk,	636	191	475	200	10
Worcester,	110	321	302[6]	250	227
	1,407	2,282	2,449	1,875	1,472

[1] Exclusive of State institutions and private paying institutions.

[2] Method A is a computation on the basis of 1 bed to every 1,000 inhabitants.

Method B is a computation on the death basis, 1 bed for every death.

Method C is a computation on the basis of the district health officers' knowledge of local conditions, together with actual statistics of deaths and available beds.

Method D is a computation on the basis of New Bedford's experience that 86 beds have been found adequate over a period of several years for industrial population of 110,000.

For communities less than 50,000 a reduction of one-fifth is also made, corresponding to the actual lesser mortality rate of such communities when compared with 50,000 cities as a group.

[3] No reduction made in method D for counties which contain cities of 50,000 or over. A reduction of one-fifth is made for those counties which contain no such cities.

[4] Includes Dukes and Nantucket.

[5] Including provisions for consumptives from Franklin and Hampshire in one institution.

[6] Showing deaths in other than local tuberculosis institutions taken out.

TABLE II. — *Average Deaths per Year from Pulmonary Tuberculosis in Massachusetts in Cities over 50,000 (1910–14 inclusive).*

CITIES.	Population, 1915.	Annual Average (1910-14).
Boston,	745,439	1,050.8
Worcester,	162,697	159.6
Fall River,	124,791	161.2
Lowell,	107,978	112.8
Cambridge,	108,822	196.8[1]
New Bedford,	109,568	124.4
Lynn,	95,803	84.2
Springfield,	102,971	77.8
Lawrence,	90,259	108.0[2]
Somerville,	86,854	78.2
Holyoke,	60,816	71.8
Brockton,	62,288	46.2
	1,858,286	–

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[1] The Holy Ghost Hospital has many inmates from other parts of greater Boston; beds, 65.

[2] Lawrence Tuberculosis Hospital cares for other city and State cases. Adequate for local needs if better sex division.

Table IIa. — *Estimated Additional Hospital Provision needed in the Various Cities of the Commonwealth having a Population of 50,000 and Over.*

Cities.	Actual Number of Beds.	Additional Beds needed by Method A.[1]	Additional Beds needed by Method B.[1]	Additional Beds needed by Method C.[1],[2]	Additional Beds needed by Method D.[1]
Boston,	636	109	415	-	53[3]
Worcester,	55	108	105	-	72
Fall River,	60	65	101	-	38
Lowell,	-	108	113	-	84
Cambridge,	110	1[3]	22	-	25[3]
New Bedford,	86	24	38	-	-
Lynn,	60	36	24	-	15
Springfield,	26	77	52	-	55
Lawrence,	88	2	20	-	17[3]
Somerville,	20	67	58	-	48
Holyoke,	27	34	45	-	21
Brockton,	-	62	46	-	49
	1,168	692	1,039	-	382

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[1] Method A is a computation on the basis of 1 bed to every 1,000 inhabitants.

Method B is a computation on the death basis, 1 bed for every death.

Method C is a computation on the basis of the district health officer's knowledge of local conditions, together with actual statistics of deaths and available beds.

Method D is a computation on the basis of New Bedford's experience that 86 beds have been found adequate over a period of several years for an industrial population of 110,000.

[2] Not computed.

[3] Estimates on basis method D indicate existing surplus of this number of beds.

TABLE III. — *Average Deaths per Year from Pulmonary Tuberculosis in Massachusetts by Counties (minus Cities over 50,000) (1910–14 inclusive).*

COUNTIES.	Population, 1915.	Annual Average (1910-14).
Barnstable,	28,818	22.2
Berkshire,	114,709	95.6
Bristol,[1]	112,605	113.4
Dukes,	4,904	2.4
Essex,[2]	277,600	279.0
Franklin,	48,256	30.4
Hampden,[3]	99,157	144.0
Hampshire,	69,549	63.2
Middlesex,[4]	429,970	596.6
Nantucket,	3,166	2.2
Norfolk,	201,907	161.6
Plymouth,[5]	95,015	155.8
Suffolk,[6]	81,362	60.4
Worcester,[7]	268,006	298.2
	1,835,024	–

[1] Minus Fall River and New Bedford.
[2] Minus Lawrence and Lynn.
[3] Minus Holyoke and Springfield.
[4] Minus Cambridge, Lowell and Somerville.
[5] Minus Brockton.
[6] Minus Boston.
[7] Minus Worcester.

TABLE IIIA. — *Estimated Additional Hospital Provision needed in the Various Counties (minus Cities over 50,000) of the Commonwealth.*

COUNTIES.	Actual Number of Beds.[1]	Additional Beds needed by Method A.[2]	Additional Beds needed by Method B.[2]	Additional Beds needed by Method C.[2, 3]	Additional Beds needed by Method D.[2]
Barnstable,	–	29	22	–	18
Berkshire,	22	93	74	–	50
Bristol,[4]	–	113	113	–	70
Dukes,	–	5	2	–	3
Essex,[5]	52	226	227	–	122
Franklin,	–	–[6]	–[6]	–	–[6]
Hampden,[7]	14	85	72[8]	–	48
Hampshire,	40	78[6]	53[6]	–	33[6]
Middlesex,[9]	42	388	291[8]	–	227
Nantucket,	–	3	2	–	2
Norfolk,	14	188	148	–	112
Plymouth,[10]	–	95	84[8]	–	59
Suffolk,[11]	–	81	60	–	51
Worcester,[12]	55	213	97[8]	–	113
	239	1,597	1,250	–	908

[1] Exclusive of beds in State tuberculosis institutions and private paying institutions.

[2] Method A is a computation on basis of 1 bed to every 1,000 inhabitants.

Method B is a computation on the death basis, 1 bed for every death.

Method C is a computation on the basis of the district health officers' knowledge of local conditions, together with actual statistics of deaths and available beds.

Method D is a computation on the basis of New Bedford's experience that 86 beds have been found adequate over a period of several years for an industrial population of 110,000.

For communities less than 50,000 a reduction of one-fifth is also made from these figures, corresponding to the actual lesser mortality rate of such communities when compared with the 50,000 cities as a group.

[3] Not computed.

[4] Minus Fall River and New Bedford.

[6] Minus Lawrence and Lynn.

[6] Including provisions for consumptives from Franklin and Hampshire counties in one institution.

[7] Minus Holyoke and Springfield.

[8] Showing deaths in other than local tuberculosis institutions deducted.

[9] Minus Cambridge, Lowell and Somerville.

[10] Minus Brockton.

[11] Minus Boston.

[12] Minus Worcester.

TABLE IV. — *Deaths from Pulmonary Tuberculosis in the State Sanatoria and Penal Institutions of Massachusetts (1910–14 inclusive).*

	1910.	1911.	1912.	1913.	1914.	Average.
North Reading, ...	54	64	59	75	65	63.4
Lakeville, ...	28	62	55	71	91	61.4
Westfield, ...	52	69	73	51	43	57.6
Rutland, ...	12	52	43	35	37	35.8
Tewksbury, ...	216	212	189	202	188	201.4
Rutland Prison Camp,[1] . .	9	14	16	3	9	10.2
State Farm, Bridgewater, . .	13	9	21	9	5	11.4

Years taken are from November 30 to November 30.

[1] The Rutland Prison Camp figures are deaths presumably from pulmonary tuberculosis.

FOOD AND DRUG INSPECTION.

The report of the Food and Drug Division presents in detail the work of food and drug inspection for the year ended Nov. 30, 1916. The following personnel comprised the laboratory force: —

HERMANN C. LYTHGOE,	*Analyst.*
CHARLES H. HICKEY,	*Assistant Analyst.*
LEWIS I. NURENBERG,	*Assistant Analyst.*
CLARENCE E. MARSH,	*Assistant Analyst.*
KATHARINE E. ROONEY,	*Assistant Analyst.*
DANIEL E. MCCARTHY,	*Inspector.*
FREDERICK L. MARION,	*Inspector.*
MAURICE P. CROWE,	*Inspector.*
JAMES S. KENNEALLY,	*Inspector.*

The number of samples examined during this period, together with a summary of work done since the passage of the law in 1882, follows: —

Food and Drug Inspection (1882–1916).

SUMMARY.	YEARS.	
	1916.	Total. 1882–1916.
Number of samples of milk examined,	7,958	148,496
Number of samples above standard,	6,183	100,927
Number of samples below standard,	1,775	47,569
Number of samples of other kinds of food examined (not milk),	2,330	76,498
Number of samples of good quality,	1,810	62,197
Number of samples adulterated, as defined by the statutes,	520	14,301
Number of samples of drugs examined,	874	28,968
Number of samples of good quality,	697	20,347
Number of samples adulterated, as defined by the statutes,	177	8,621
Total examination of food and drugs,	11,162	253,962
Total samples of good quality,	8,690	183,471
Total samples not conforming to the statutes,	2,472	70,491

Section 7 of chapter 75 of the Revised Laws provides that the State Board of Health "shall annually report to the general court the number of prosecutions made under the provisions of sections sixteen to twenty-seven, inclusive, and an itemized account of the money expended in carrying out the provisions thereof;" and in accordance with this provision the following report is made.

The total number of prosecutions entered during the fiscal year ended Nov. 30, 1916, was 196. Of these, 175 resulted in conviction, 19 were discharged, 1 was dismissed for want of prosecution, and 1 was defaulted.

The amount of fines imposed was $7,241.80, which brings the sum total to $106,982.02.

PROSECUTIONS.

The following table presents the statistics relative to the prosecutions which have been conducted under the food and drug acts since the beginning of the work in 1883 (Revised Laws, chapter 75, sections 16 to 27): —

Number of Complaints entered in Court.

YEAR.	Food and Other Articles (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines imposed.
1883, ...	–	5	4	9	8	–[1]
1884, ...	2	1	45	48	44	–[1]
1885,[2] . . .	50	1	68	119	103	–[1]
1886,[3] . . .	10	–	10	20	19	–[1]
1887, ...	30	–	34	64	60	–[1]
1888, ...	22	–	43	65	61	$2,042 00
1889, ...	74	–	66	140	124	3,889 00
1890, ...	78	–	24	102	96	3,919 00
1891, ...	96	5	49	150	135	2,668 00
1892, ...	52	12	72	136	123	3,661 70
1893, ...	26	3	67	96	92	2,476 00
1894, ...	14	–	76	90	77	2,625 00
1895, ...	13	11	68	92	86	2,895 30
1896, ...	7	–	68	75	74	2,812 20
1897, ...	13	1	51	65	64	2,756 60
1898, ...	10	–	54	64	62	2,060 98
1899, ...	19	2	26	47	45	1,432 66
1900, ...	45	5	44	94	89	1,890 70
1901, ...	30	–	65	95	90	1,874 70
1902, ...	25	3	48	76	74	2,617 98
1903, ...	34	1	44	79	70	1,297 66
1904, ...	6	6	50	62	57	1,509 00
1905, ...	209	27	77	313	275	8,486 00
1906[4]	177	60	171	409	833	7,316 00
1907, ...	123	63	147	333	290	6,546 00
1908, ...	76	138	219	433	386	8,300 30
1909, ...	72	44	180	296	267	5,666 74
1910, ...	112	26	119	257	244	5,395 21

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[1] No record kept.

[2] To May 1, 1886.

[3] Four months only.

[4] Fourteen months, from Sept. 30, 1905.

Number of Complaints entered in Court — Concluded.

YEAR.	Food and Other Articles (not including Milk).	Drugs.	Milk.	Total.	Convictions.	Fines imposed.
1911,	49	30	82	161	147	$4,015 91
1912,	20	36	65	121	111	2,805 00
1913,	36	19	106[1]	161	116	2,922 75
1914,	44	36	58	138	114	2,438 50
1915,	72	23	74[2]	169	158	3,424 33
1916,	114	19	63	196	175	7,241 80

[1] One case was on account of obstruction of an inspector.

[2] Two cases were on account of obstruction of inspectors, and two were for assault and battery and cruelty to horse.

The nature of the offences brought to the attention of the courts during the year, the names of the defendants, the places where the offences were committed, the date of trial or indictment, and the results of the prosecutions, are set forth in the following table: —

For Sale of Milk not of Good Standard Quality.

NAME.	Address.	Court.	Date.	Result.
Champagne, Jeremie,	Lowell,	Lowell,	Apr. 27, 1916	Conviction.
Delyannis, Trianpa G.,	Hull,	Hingham,	July 28, 1916	Conviction.
Stevens, George,	Somerville,	Somerville,	Nov. 28, 1916	Discharged.
Stone, David,	Hull,	Hingham,	July 28, 1916	Conviction.
Yee, Charlie,	Onset,	Wareham,	Aug. 24, 1916	Conviction.

For Sale of Milk from which a Portion of the Fat had been removed.

NAME.	Address.	Court.	Date.	Result.
Beatty, John S.,	Webster,	Webster,	Aug. 22, 1916	Conviction.[1]
Casey, John F.,	Worcester,	Worcester,	May 1, 1916	Conviction.
Crowley, William P.,	Needham,	Newton,	July 6, 1916	Conviction.
Crowley, William P.,	Needham,	Newton,	July 6, 1916	Conviction.
Crowley, William P.,	Needham,	Newton,	July 6, 1916	Conviction.
Hammond, Arthur B., and Robbins, Charles A.	Onset,	Wareham,	Aug. 24, 1916	Conviction.
Hoffman, John H.,	Onset,	Wareham,	Aug. 24, 1916	Conviction.

[1] Appealed.

For Sale of Milk from which a Portion of the Fat had been removed — Concluded.

NAME.	Address.	Court.	Date.	Result.
Hood, Frank L.,	Athol,	Athol,	Sept. 30, 1916	Conviction.
Killam, Henry D.,	Lawrence,	Lawrence,	June 16, 1916	Conviction.
Morrow, Artemus L.,	Braintree,	Quincy,	Nov. 8, 1916	Conviction.
Small, Charles E.,	Berlin,	Clinton,	June 27, 1916	Discharged.
Steele, Joseph,	Provincetown,	Provincetown,	Aug. 23, 1916	Conviction.
Waters, Charles H.,	Onset,	Wareham,	Aug. 24, 1916	Conviction.
Winch, Harvey O.,	Templeton,	Gardner,	July 26, 1916	Conviction.
Wisnowski, Frank,	New Bedford,	New Bedford,	July 24, 1916	Conviction.

For Sale of Milk containing Added Water.

Angier, Charles,	Lowell,	Lowell,	Nov. 28, 1916	Conviction.
Angier, John,	Lowell,	Lowell,	Nov. 28, 1916	Conviction.
Bardwell, Albert,	Westborough,	Westborough,	June 30, 1916	Discharged.
Bearse, Clarabel,	South Hyannis,	Barnstable,	Jan. 10, 1916	Conviction.
Benz, Charles F.,	Pittsfield,	Pittsfield,	Oct. 20, 1916	Conviction.
Braverman, Herman,	Taunton,	Taunton,	May 4, 1916	Conviction.[1]
Cabral, John,	Fairhaven,	New Bedford,	June 6, 1916	Conviction.
Carter, Margaret M.,	Wakefield,	Malden,	Nov. 23, 1916	Conviction.
Castongua, Augustus,	Amesbury,	Amesbury,	Dec. 21, 1915	Conviction.
Chisholm, Thomas M.,	South Weymouth,	Quincy,	Nov. 15, 1916	Conviction.
Cockran, Lewis,	Carlisle,	Concord,	Aug. 28, 1916	Conviction.
Coray, Manuel,	Fall River,	Fall River,	Oct. 23, 1916	Conviction.
Frost, Fred H.,	Westborough,	Westborough,	June 30, 1916	Conviction.
Hjelm, Carl,	Hingham,	Hingham,	Aug. 14, 1916	Conviction.
Jackson, Estate of Wm. O.,	Furnace,	East Brookfield,	Sept. 11, 1916	Conviction.
Kelly, Abraham,	Norwood,	Dedham,	Nov. 7, 1916	Conviction.[1]
Krikorian, Heghnor,	Methuen,	Lawrence,	June 2, 1916	Conviction.
Leit, Manuel C.,	Acushnet,	New Bedford,	Oct. 16, 1916	Conviction.
Linscott, Leonard C.,	Hingham,	Hingham,	Oct. 27, 1916	Conviction.
Linscott, Leonard C.,	Hingham,	Hingham,	Oct. 27, 1916	Conviction.
McDonald, Charles,	Kingston,	Plymouth,	Sept. 6, 1916	Conviction.[1]
Mello, Angelo,	Fairhaven,	New Bedford,	Oct. 16, 1916	Conviction.
Montenari, Louis,	Plymouth,	Plymouth,	Sept. 6, 1916	Conviction.[1]
Murray, James,	Plymouth,	Plymouth,	Jan. 21, 1916	Conviction.

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[1] Appealed.

For Sale of Milk containing Added Water — Concluded.

NAME.	Address.	Court.	Date.	Result.
O'Brine, James,	Lincoln,	Concord,	May 18, 1916	Conviction.
O'Keefe, Philip J.,	Wareham,	Middleborough,	Nov. 25, 1916	Conviction.
Peters, James C.,	Salem, N. H.,	Lawrence,	Mar. 22, 1916	Conviction.[1]
Pike, Charles S.,	West Andover,	Lawrence,	Aug. 10, 1916	Conviction.[1]
Poyant, George,	South Dartmouth,	New Bedford,	Jan. 7, 1916	Conviction.
Ray, Minnie A.,	Haverhill,	Haverhill,	May 23, 1916	Conviction.
Ricker, Edward S.,	Carlisle,	Concord,	May 18, 1916	Conviction.
Silva, Joseph D.,	Mansfield,	Attleboro,	Apr. 13, 1916	Conviction.
Silverman, Dinah,	Hull,	Hingham,	Nov. 3, 1916	Conviction.
Tancrelle, Alpha,	Mendon,	Milford,	July 8, 1916	Conviction.
Thomas, Frank,	Norwell,	Hingham,	Aug. 14, 1916	Conviction.
Tomkiewicz, Jacob,	Shawmut,	New Bedford,	Oct. 16, 1916	Conviction.
Volta, Vincent,	Plymouth,	Plymouth,	Sept. 6, 1916	Conviction.[1]

For Sale of Milk containing Added Foreign Matter.[2]

NAME.	Address.	Court.	Date.	Result.
Alves, Frank L.,	Blackstone,	Blackstone,	May 26, 1916	Discharged.
Bashaw, Charles G.,	Newburyport,	Newburyport,	May 11, 1916	Conviction.
Courtemanche, Thomas,	Mendon,	Milford,	June 12, 1916	Conviction.
Lamouthe, Joseph,	Blackstone,	Blackstone,	May 17, 1916	Discharged.
Lemieux, Adolphus,	Salisbury,	Newburyport,	Aug. 11, 1916	Conviction.
Worth, Howard T.,	Mendon,	Mendon,	June 12, 1916	Conviction.

For Sale of Cream not of Good Standard Quality.

NAME.	Address.	Court.	Date.	Result.
Varney, Clyde H.,	Springfield,	Springfield,	June 14, 1916	Conviction.

For Sale of Ice Cream below Standard.

NAME.	Address.	Court.	Date.	Result.
Tarment, John H.,	Foxborough,	Attleboro,	Aug. 25, 1916	Conviction.
Tarment, John H.,	Foxborough,	Attleboro,	Aug. 25, 1916	Conviction.

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[1] Appealed.

[2] Dirt.

For Sale of Adulterated Foods Other than Milk and Milk Products.

CIDER.

Contained Benzoic Acid.

NAME.	Address.	Court.	Date.	Result.
Henihan, Matthew, . .	Jamaica Plain, .	Jamaica Plain, .	Jan. 27, 1916	Conviction.
Killam, Henry D., . .	Lawrence, . .	Lawrence, . .	June 16, 1916	Conviction.
Tzacoyianes, James, . .	Allston, . . .	Brighton, . .	Jan. 22, 1916	Conviction.

HAMBURG STEAK.

Contained a Compound of Sulphurous Acid.

Abrams, Max, . . .	Dorchester, . .	Dorchester, .	Oct. 4, 1916	Conviction.
Berman, Max, . . .	Boston, . . .	Boston, . .	July 13, 1916	Conviction.[1]
Cooper, David, . . .	Boston, . . .	Roxbury, . .	Nov. 21, 1916	Conviction.[1]
Dinnerman, John H., . .	Charlestown, . .	Charlestown, .	June 30, 1916	Conviction.[1]
DiSalvatori, Peter, . .	Boston, . . .	Boston, . .	July 7, 1916	Conviction.
Edelstein, Max, . . .	Boston, . . .	Boston, . .	July 7, 1916	Conviction.[1]
Golwasser, Max, . . .	Boston, . . .	Boston, . .	July 13, 1916	Conviction.
Gorodetzer, Philip, . .	Chelsea, . . .	Chelsea, . .	July 14, 1916	Conviction.
Jaffe, Charles J., . . .	Charlestown, . .	Charlestown, .	July 11, 1916	Conviction.[1]
Kofman, Philip, . . .	Roxbury, . .	Roxbury, . .	July 26, 1916	Conviction.
Levine, Louis, . . .	Roxbury, . .	Roxbury, . .	Apr. 24, 1916	Conviction.
Levine, Louis, . . .	Roxbury, . .	Roxbury, . .	Apr. 24, 1916	Conviction.
Leviton, Harry, . . .	Boston, . . .	Boston, . .	May 24, 1916	Conviction.[1]
Lipsky, Abram, . . .	Roxbury, . .	Roxbury, . .	May 29, 1916	Conviction.[1]
Margolis, Jacob, . . .	Boston, . . .	Boston, . .	July 13, 1916	Dismissed for want of prosecution.
McAuliffe, Jeremiah, . .	Boston, . . .	Boston, . .	July 7, 1916	Conviction.
Paoni, Andreas, . . .	East Boston, .	East Boston, .	Nov. 10, 1916	Conviction.
Rosin, Morris, . . .	Boston, . . .	Roxbury, . .	June 5, 1916	Conviction.
Rumkus, Anthony, . .	South Boston, .	South Boston, .	June 8, 1916	Conviction.
Schwartz, Hyman, . .	Boston, . . .	Boston, . .	July 7, 1916	Conviction.
Scott, George W., . . .	Roxbury, . .	Roxbury, . .	May 29, 1916	Conviction.
Vincent, Lemuel, . . .	Boston, . . .	Roxbury, . .	Nov. 21, 1916	Conviction.
Waliakas, John, . . .	South Boston, .	South Boston, .	June 29, 1916	Conviction.
Ward, Louis, ...	Roxbury, . .	Roxbury, . .	July 26, 1916	Conviction.

[1] Appealed.

For Sale of Adulterated Foods Other than Milk and Milk Products — Continued.

MAPLE SUGAR.

Contained Cane Sugar.

NAME.	Address.	Court.	Date.	Result.
Coleman, Edward F., . .	Lynn, . . .	Lynn, . .	May 17, 1916	Conviction.
Fortini, Leonardo, . .	Boston, . . .	Boston, . .	June 7, 1916	Conviction.
Fortini, Leonardo, . .	Boston, . . .	Boston, . .	June 7, 1916	Conviction.
Lofus, Michael, . . .	Fitchburg, . .	Fitchburg, .	May 12, 1916	Conviction.
Maffeo, Charles, . . .	Fitchburg, . .	Fitchburg, .	May 12, 1916	Conviction.
Malagodi, A., . . .	Whitman, . .	Abington, . .	June 1, 1916	Conviction.[1]
Petros, Peter, and Chires, Phillip.	Lynn, . . .	Lynn, . .	May 17, 1916	Conviction.
Petros, Peter, and Chires, Phillip.	Lynn, . . .	Lynn, . .	May 17, 1916	Conviction.
Raini, Louis, . . .	Springfield, . .	Springfield, .	May 26, 1916	Conviction.
Romano, Patsy, . . .	Fitchburg, . .	Fitchburg, .	May 12, 1916	Conviction.
Scafidi, Marino, . . .	Boston, . . .	Boston, . .	June 15, 1916	Conviction.[1]
Silver, Araga, . . .	Springfield, . .	Springfield, .	May 26, 1916	Conviction.

OLIVE OIL.

Entirely Cottonseed Oil.

Bazagian, Sarkis, . . .	Lawrence, . .	Lawrence, . .	Dec. 8, 1915	Conviction.[1]

SAUSAGE.

Contained Cereal or Vegetable Flour in Excess of 2 Per Cent.

Beauchamp, Oliva, . .	Holyoke, . .	Springfield, .	May 26, 1916	Conviction.
Berlo, Henry H., . . .	Boston, . . .	Boston, . .	Jan. 21, 1916	Conviction.
Boran, John, ...	Fall River, . .	Fall River, .	Feb. 18, 1916	Conviction.[1]
Boran, John, ...	Fall River, . .	Fall River, .	Feb. 18, 1916	Conviction.[1]
Claus, Ambrose, . . .	Boston, . . .	Roxbury, . .	Jan. 13, 1916	Conviction.
Close, Hubert, . . .	Pittsfield, . .	Pittsfield, . .	Jan. 12, 1916	Conviction.
Coleise, John, . . .	Boston, . . .	Roxbury, . .	Jan. 25, 1916	Conviction.
Eberwein, John, . . .	Pittsfield, . .	Pittsfield, . .	Jan. 12, 1916	Conviction.
Furneaux, Henry J., . .	Lawrence, . .	Lawrence, . .	Feb. 29, 1916	Discharged.
Furneaux, Henry J., . .	Lawrence, . .	Lawrence, . .	Feb. 29, 1916	Discharged.
Hernicke, Max, . . .	Holyoke, . .	Holyoke, . .	June 14, 1916	Conviction.
Parks Sausage and Provision Company.	Boston, . . .	Boston, . .	June 7, 1916	Discharged.
Roberts, Benjamin L., . .	Worcester, . .	Worcester, . .	May 11, 1916	Conviction.

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[1] Appealed.

For Sale of Adulterated Foods Other than Milk and Milk Products — Concluded.

SAUSAGE — *Concluded.*

Contained Cereal or Vegetable Flour in Excess of 2 Per Cent. — Concluded.

NAME.	Address.	Court.	Date.	Result.
Sichel, Herman,	Roxbury,	Somerville,	Nov. 21, 1916	Conviction.
Sichel, Herman,	Roxbury,	Roxbury,	Nov. 29, 1916	Conviction.[1]
Sichel Provision Company,	Boston,	Roxbury,	Mar. 10, 1916	Conviction.
Sweeney, Myles J.,	Boston,	Boston,	Jan. 21, 1916	Conviction.
Thompson, David A.,	Central Falls, R. I.,	Worcester,	June 21, 1916	Conviction.
Wagner, Robert,	Fitchburg,	Fitchburg,	Apr. 13, 1916	Conviction.
Weitz, Carl A.,	Boston,	Boston,	Feb. 25, 1916	Conviction.
Weitz, Carl A.,	Boston,	Boston,	Feb. 25, 1916	Conviction.
Weitz, Carl A.,	Boston,	Boston,	Feb. 25, 1916	Conviction.
Whatmough, Arthur,	Taunton,	Taunton,	Jan. 14, 1916	Discharged.
Whatmough, John T.,	Taunton,	Taunton,	Jan. 14, 1916	Discharged.
Wiedeman, Donat,	Boston,	Boston,	Jan. 21, 1916	Conviction.
Zajack, John,	Lawrence,	Lawrence,	Feb. 29, 1916	Conviction.

Contained Coloring Matter.

Whatmough, Arthur,	Taunton,	Taunton,	Jan. 14, 1916	Conviction.
Whatmough, John T.,	Taunton,	Taunton,	Jan. 14, 1916	Conviction.

SCALLOPS.

Contained Added Water.

Anthony, George W.,	Chelsea,	Chelsea,	Mar. 1, 1916	Conviction.
Anthony, George W.,	Chelsea,	Chelsea,	Mar. 9, 1916	Conviction.
Barry, James,	Boston,	Boston,	Dec. 8, 1915	Conviction.
Odell, Nathaniel,	Everett,	Malden,	Dec. 22, 1915	Discharged.

VANILLA EXTRACT.

Contained an Alcoholic Solution of Vanillin.

Bell, Frank, & Torrie,	Boston,	Waltham,	Dec. 9, 1915	Conviction.
Bell, Frank, & Torrie,	Boston,	Waltham,	Dec. 9, 1915	Conviction.

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[1] Appealed.

For Sale of Decomposed Food.

EGGS.[1]

NAME.	Address.	Court.	Date.	Result.
American Egg Company,	Boston,	Boston,	Mar 17, 1916	Conviction.[2]
Brown, Morris,	Boston,	Boston,	Jan. 18, 1916	Conviction.[2]
Brown, Morris,	Boston,	Roxbury,	Jan. 25, 1916	Conviction.[2]
Brown, Morris,	Boston,	Charlestown,	Jan. 26, 1916	Conviction.[2]
Bunshaft, Benjamin,	Boston,	Boston,	Feb. 25, 1916	Discharged.
Bunshaft, Benjamin,	Boston,	Boston,	Feb. 25, 1916	Discharged.
Bunshaft, Benjamin,	Boston,	Boston,	Feb. 25, 1916	Discharged.
Cohen, Lewis,	Boston,	Boston,	Jan. 18, 1916	Conviction.[2,3]
Eisenberg, Joseph,	Boston,	Boston,	Mar. 17, 1916	Conviction.[2]
Eisenberg, Joseph,	Boston,	Boston,	Mar. 17, 1916	Conviction.[2]
Freedman Stahl Baking Company.	Boston,	Roxbury,	Jan. 25, 1916	Conviction.[2,3]
Garman, Israel,	Boston,	Boston,	Jan. 18, 1916	Conviction.[2,3]
Goldstein, Hyman,	Chelsea,	Boston,	Mar. 20, 1916	Conviction.
Gottfried, Israel I.,	Everett,	East Boston,	Jan. 12, 1916	Conviction.[2]
Gottfried, Israel I.,	Everett,	Boston,	Mar. 17, 1916	Conviction.[2]
Gottfried, Samuel,	Boston,	Boston,	Mar. 17, 1916	Conviction.[2]
Greenglass, Barney,	Chelsea,	Chelsea,	Mar. 1, 1916	Conviction.
North American Egg Company.	Everett,	Everett,	Jan. 20, 1916	Defaulted.[4]
North American Egg Company.	Everett,	East Boston,	Feb. 12, 1916	Conviction.[2]
Pollen, Jacob,	Everett,	East Boston,	Jan. 12, 1916	Conviction.[2]
Pollen, Jacob,	Everett,	Boston,	Feb. 17, 1916	Conviction.[2,3]
Pollen, Jacob,	Everett,	Chelsea,	Feb. 28, 1916	Discharged.
Pollen, Jacob,	Everett,	Boston,	Mar. 17, 1916	Conviction.[2]
Rottenberg, Oscar,	Boston,	Boston,	Mar. 17, 1916	Conviction.[2]
Rutstein, Frank,	Chelsea,	Chelsea,	Feb. 28, 1916	Conviction.
Seliger, Benjamin,	Boston,	Boston,	Jan. 18, 1916	Conviction.[2,3]
Shaw, Abraham,	Chelsea,	Boston,	Mar. 20, 1916	Discharged.
Shwerer, Max,	Boston,	Boston,	Mar. 17, 1916	Conviction.[2]
Silver, Louis,	Chelsea,	Chelsea,	Feb. 28, 1916	Discharged.
Silverstein, Lewis,	Boston,	Boston,	Jan. 18, 1916	Conviction.[2,3]
Stahl, David,	Boston,	Boston,	Jan. 18, 1916	Conviction.[2,3]
Standard Egg Company,	Boston,	Boston,	Mar. 17, 1916	Conviction.[4]
Zion, Abram,	Boston,	Boston,	Mar. 17, 1916	Conviction.[2]

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[1] The majority of these eggs were broken-out eggs in cold storage.

[2] Appealed.

[3] Evidence furnished by city of Boston health department.

[4] Fine paid on default.

For Sale of Decomposed Food — Concluded.

BEEF.

NAME.	Address.	Court.	Date.	Result.
Hill, Louis, ...	Framingham, .	Framingham, .	Mar. 4, 1916	Conviction.

SAUSAGE MEAT.

Ormond, George G., . .	Quincy, . .	Quincy, . .	Apr. 26, 1916	Conviction.

SHRIMP.

New Bedford Public Market,	New Bedford, .	New Bedford, .	July 14, 1916	Conviction.[1]

SWORDFISH.

Barry, James, . . .	Boston, . . .	Boston, . .	Dec. 8, 1915	Conviction.

For accepting Decomposed Eggs in an Establishment where Food Products are prepared.

Rizzo, Gusippe, . . .	Boston, . . .	Boston, . .	Feb. 17, 1916	Conviction.[1]

For Misuse of Milk Bottle.

Mettell, Max, . . .	Canton, . . .	Stoughton, .	May 13, 1916	Conviction.

For Sale of Drugs Deficient in Strength.

ALCOHOL.

Allen, Fred P., . . .	Fitchburg, . .	Fitchburg, .	Apr. 25, 1916	Conviction.
Lerner, Charles, . . .	Boston, . . .	West Roxbury, .	June 13, 1916	Conviction.
O'Hearne, James J., . .	Taunton, . .	Taunton, . .	Nov. 27, 1916	Conviction.[1]
Stone, Benjamin, . .	Taunton, . .	Taunton, . .	Oct. 26, 1916	Conviction.

SPIRIT OF ANISE.

Cornier, Amedee L., . .	Marlborough, . .	Marlborough, .	June 24, 1916	Conviction.
Hirshon, Max G., . . .	Boston, . . .	Boston, . .	Nov. 3, 1916	Conviction.
Villeneuve, Arthur A., . .	Dorchester, . .	Dorchester, .	May 11, 1916	Conviction.[1]

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[1] Appealed.

For Sale of Drugs Deficient in Strength — Concluded.

SPIRIT OF CAMPHOR.

NAME.	Address.	Court.	Date.	Result.
Fox, Philip F.,	Holyoke,	Holyoke,	July 21, 1916	Conviction.
Gifford, Edward R.,	Dorchester,	Dorchester,	Aug. 11, 1916	Conviction.[1]
Honen, William L.,	Roxbury,	Roxbury,	Oct. 19, 1916	Conviction.[1]

SPIRIT OF PEPPERMINT.

NAME.	Address.	Court.	Date.	Result.
Berlant, Moses,	Boston,	Dorchester,	July 7, 1916	Conviction.
Cloutier, Eusebe,	Fall River,	Fall River,	Feb. 18, 1916	Conviction.
Cornier, Amedee L.,	Marlborough,	Marlborough,	June 24, 1916	Conviction.

TINCTURE OF IODINE.

NAME.	Address.	Court.	Date.	Result.
Belmarsh, Philip,	Roxbury,	Roxbury,	Oct. 10, 1916	Conviction.
Hooper, George H.,	Brookline,	Brookline,	Sept. 27, 1916	Discharged.

For Sale of Drugs not up to the Professed Standard under which they were sold.

BACILLUS BULGARICUS TABLETS.

NAME.	Address.	Court.	Date.	Result.
Parke, Davis & Co.,	Boston,	Boston,	July 28, 1916	Discharged.

For refusing to furnish a Sample for Analysis to an Inspector of the State Department of Health.

NAME.	Address.	Court.	Date.	Result.
Atkinson, Fred J.,	Boston,	Boston,	Oct. 11, 1916	Conviction.[1]
Bowden, John J.,	Boston,	Boston,	Oct. 11, 1916	Conviction.[1]
Parke, Davis & Co.,	Boston,	Boston,	Oct. 11, 1916	Conviction.[1]

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[1] Appealed.

The amount of the fines imposed was $7,241.80, as follows: —

Milk and milk products,	$1,985 00
Foods other than above,	4,551 80
Drugs,	705 00
	$7,241 80

The total number of samples of food, drugs, liquors and poisons examined during the year was as follows: —

Milk,	7,958
Food,[1]	2,330
Drugs,	874
Liquors,	51
Poisons,	200
Linseed oil and turpentine,	2
	11,415

EXPENDITURES UNDER THE PROVISIONS OF THE FOOD AND DRUG ACTS FOR THE YEAR ENDED NOV. 30, 1916.

Appropriation,	$17,500 00
Salaries of analysts,	$5,671 67
Salaries of inspectors,	5,969 89
Salaries of office assistants,	1,219 17
Traveling expenses,	2,407 24
Purchase of samples,	434 62
Apparatus and chemicals,	684 57
Express,	10 34
Printing,	124 62
Books, maps and stationery,	235 59
Telephone and telegraph messages and postage,	203 83
Sundry laboratory supplies,	102 54
Typewriting supplies and repairs,	151 52
Services (cleaning laboratory),	143 00
Extra services,	99 03
Miscellaneous,	25 45
Advertising,	10 05
Total,	$17,493 13
Unexpended balance,	6 87
	$17,500 00

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[1] Includes articles held in cold storage.

DIVISION OF SANITARY ENGINEERING.

DIVISION OF SANITARY ENGINEERING.

ADVICE TO CITIES, TOWNS AND OTHERS RELATIVE TO WATER SUPPLY, DRAINAGE AND SEWERAGE.

In the following pages is given the substance of the action of the Department upon the more important matters presented to it during the year under the laws relating to the protection of inland waters, including advice to cities, towns and persons relative to water supply, drainage, sewerage and matters pertaining thereto.

WATER SUPPLY.

ASHBURNHAM.

A request was received from the Board of Water Commissioners of the town of Ashburnham on Nov. 8, 1915, for information as to the condition of the old reservoir in that town. After considering the results of a thorough study of the occurrence of cases of typhoid fever in the village in the months of October and November the Department, on Jan. 25, 1916, replied as follows: —

> The results of that investigation do not indicate that the water of the old reservoir was a source of infection, and there is no indication from an examination of the water in the early part of November that it was being polluted at that time or likely to be injurious to the health of those to whom it was supplied for drinking. This reservoir, however, is located very close to the town and is exposed to possible danger of pollution by visitors. Furthermore, the reservoir is small and leaks considerably, and the period of storage for water entering it is not great.
>
> The town is provided with a system of water works for supplying water from Upper Naukeag Pond, a source which furnishes water of good quality and can be protected much more effectively than the small reservoir near the village.
>
> In view of these circumstances, the Department recommends that the further use of the small reservoir be discontinued and that the supply of the town be taken hereafter from Upper Naukeag Pond.

ATTLEBORO.

In response to a request from the Health Department of Attleboro for advice as to granting permits for fishing on Orr's Pond, the Department, under date of June 28, 1916, replied as follows: —

> It appears that this pond is maintained for use as a supplementary supply in connection with your present sources of water supply and that in times of emergency water is sometimes drawn from this source for the supply of the town.
>
> The granting of permits to boat and fish upon this pond would involve a very considerable danger of the pollution of its waters and, under the circumstances, the Department recommends that boating and fishing upon this pond be prevented.

BELLINGHAM.

On March 3, 1916, an application was received from the board of selectmen of Bellingham requesting approval by the Department of a proposed water supply for the town to be taken from the works of the town of Medway. The application was accompanied by a plan which provided for extending a pipe from the water works system of the town of Medway to serve the villages of Caryville and North Bellingham, under the provisions of chapter 25 of the Revised Laws and chapter 218 of the Acts of the year 1913. On May 3, 1916, the Department replied to this application, recommending the adoption of the proposed plan.

BOSTON (COMMISSION ON MENTAL DISEASES).

Under date of Nov. 15, 1916, the Department replied as follows to a request from the director of the Commission on Mental Diseases for information relative to the condition of the water supply and sewage disposal works at the various institutions under the supervision of that commission: —

Foxborough State Hospital.

> At the Foxborough State Hospital the water is supplied from the works of the Foxborough Water Supply District, and its quality is satisfactory.
>
> The sewage filter beds in use at the present time are located very close to the buildings and, in view of the proposed enlargement of this institution, it is essential that this location be abandoned. The scheme submitted by the trustees of the hospital for the construction of a new system of works provides for an Imhoff tank, dosing tank and two acres of sand filters, to be located at a point about $\frac{1}{4}$ of a mile northeast of the institution and on the westerly side of the railroad near the shore of the Neponset Reservoir. An inspection of the locality shows that material can be found there which is suitable for the con-

struction of filters, and the location selected for the filters appears to be the best that is available for the purpose within the lands controlled by the institution, but, in the opinion of the Department, the proposed works are not likely to be adequate for the satisfactory disposal of the sewage if the quantity shall amount to that estimated by the engineers who have designed the works. It is recommended that an area of at least three acres of filters be provided for the disposal of the sewage of this institution.

Gardner State Colony.

At the Gardner State Colony an additional water supply is greatly needed. When the present source was selected, a test indicated that it would yield about 60,000 gallons per day in a dry period. The quantity of water now drawn from the wells equals this amount, and it is understood that additional wells are now being put in. It is hardly probable that additional wells will increase materially the present yield, and the Department again recommends further investigations in the localities deemed most favorable for obtaining a ground water supply in this region, as already suggested by the State Board of Health in a communication dated January 2, 1908, from which the following is quoted: —

> . . . The conditions for obtaining water freely from the ground appear to be quite favorable near the railroad about a quarter of a mile north of the locality in which the recent tests were made, and it is possible that an adequate supply of good water for the institution could be obtained in that locality. Favorable conditions are also found in the neighborhood of the railroad about a mile east of the Westminster group of cottages. . . .

The sewage of the main buildings of the Gardner Colony, known as the Receiving Group, is disposed of satisfactorily upon filter beds, and filter beds have recently been completed for the disposal of the sewage of the Gardner Group. All of these filters are operating satisfactorily. The sewage of the Seaver, Belcher, Fairview, Overlook, Highland, Bellevue, Hillcrest, Westminster and Valley Farm groups is disposed of in cesspools and blind drains, and, with the exception of the Seaver and Belcher groups, the quantity of sewage from which is small, this method of disposal results in a number of nuisances, which in some cases may become a menace to the purity of the water supply. An investigation to determine the best practicable method of sewage disposal of these various groups should be undertaken in connection with the investigation for an additional water supply.

Grafton State Hospital.

At the Grafton State Hospital the water supply has deteriorated in quality until it has become very objectionable for most uses. The yield of the source has also become inadequate for the requirements of the institution. It is important that investigations for a new supply be undertaken at once, as already recommended by the engineer of the Department.

Medfield State Hospital.

At the Medfield State Hospital the water supply obtained from the tubular wells, supplemented by water from Farm Pond, is satisfactory for all purposes.

The sewage disposal works of the Medfield State Hospital are utterly inadequate for the requirements of the institution, and large quantities of sewage are necessarily allowed to overflow into Charles River. Under date of February 15, 1916, this Department recommended the construction of 2.3 acres of additional filters, but the necessary appropriation does not appear to have been provided. It is of the greatest importance, in the opinion of the Department, that adequate sewage disposal works be provided at this institution with the least possible delay. At the present time a part of the sewage is discharged into the Charles River, a water supply stream, a gross violation by the State of its own laws for the protection of water supplies.

Monson State Hospital.

The water supplied at this institution at the present time is obtained from the mains of the Monson water works and is satisfactory for all purposes. The tests made in 1915 indicated that an ample quantity of water for all the requirements of this institution could be obtained from the ground near the Quaboag River, and it is understood that works for taking this water are now being installed.

Westborough State Hospital.

At the Westborough State Hospital both the water supply, obtained from the metropolitan water system, and the sewage disposal works of the institution are satisfactory at the present time. It appears, however, that, owing to the fact that the water supply is taken from the open channel of the Wachusett Aqueduct, a short distance below the terminus of the covered conduit, and that the water from Wachusett Reservoir is shut off during a portion of each day and at all times on Sunday, the depth of water at the hospital intake is insufficient for the proper operation of the pumps. An extension of the intake pipe up stream to the terminal chamber of the aqueduct would make it practicable for the hospital to secure a continuous supply even when the flow of water is shut off from entering the aqueduct.

Worcester State Hospital.

The water supply of the Worcester State Hospital is obtained from the city of Worcester and is satisfactory for all purposes of the institution.

The Department has caused an examination to be made as to the possibility of obtaining a separate water supply for a part or all of the uses of this institution and finds that it is possible that such a supply might be obtained in the easterly part of the hospital grounds, not far from Lake Quinsigamond. To determine this question, further investigations by means of tubular wells, including a suitable pumping test, will be necessary.

The present method of sewage disposal at this institution should be discontinued as soon as possible and a connection made with the Worcester sewerage system, as already approved under legislation of the present year.

There is a small branch of this institution in Shrewsbury known as the Hillside Farm, for which a water supply is greatly needed. An examination of the ground indicates that the limited quantity of water required can probably be obtained from the low ground south of the buildings. A sewage disposal system will probably also be required for this farm.

Wrentham State School.

At the Wrentham State School the water supply is of excellent quality and ample for all the requirements of the institution.

The sewage disposal area is probably sufficient for the requirements of the coming year, but it is essential, in the opinion of the Department, that land be acquired along the brook through which the effluent flows below the sewage filters, or some other provision made for relief from complaint in this locality. It will also be necessary to reconstruct the main sewer siphon, which does not at present operate satisfactorily, as recommended by the Department under date of September 22, 1915.

BRAINTREE.

In response to a request from the Board of Water Commissioners of Braintree for advice as to permitting boating and fishing on Little Pond, the Department, on June 28, 1916, replied as follows: —

It appears from the information available to the Department that at present your supply is drawn wholly from Great Pond through works constructed many years ago. The operation of these works, while such as to furnish a sufficient quantity of water for the town, is subject to possible danger of interruption, and it has been the custom of your board to maintain the works at Little Pond in such condition that they can be used at short notice in case of necessity.

Little Pond is located in a very densely populated region, and as no sewers have been constructed for the removal of the sewage it is very difficult to maintain the water of the pond in proper condition for domestic use. For many years, however, the danger of pollution of this water has been kept at a minimum by the efforts of your board, and the pond and its surroundings were still being maintained in the best practicable condition at the time of the recent examination.

In case it should become necessary to use the water of this pond for the supply of the town, very little warning of the necessity of such use is likely to be given and, under the circumstances, it appears to the Department highly important for the protection of the health of the town that the purity of the water should be protected as fully as practicable at all times while the danger of the possibility of its use shall continue.

Since the financial condition of the Braintree Water Department, as stated in your letter, will soon be such that the town will be able to seek better conditions for its water supply, the State Department of Health is of the opinion that definite plans should be adopted for the introduction of an adequate supply of good water at the earliest possible time and that, as soon as it is possible to provide such a supply, which apparently will be within the next three or four years, the further use of Little Pond as a source of domestic water supply, even in case of emergency, should be discontinued. The earlier an adequate supply of good water is provided for the town, the earlier will the necessity for restricting the use of Little Pond be removed.

On Aug. 22, 1916, another communication was received from the Board of Water Commissioners of Braintree relative to fishing and boating privileges on Little Pond and the establishment of rules and regulations for the sanitary protection of this pond. On Sept. 8, 1916, the Department made the following reply: —

A recent examination of Little Pond shows that the conditions in general have changed but little since the time of the previous examination though, through the efforts of your board, the surroundings of the pond are cleaner than at the time of the previous examination. A large number of dwelling houses, barns and other buildings are located in the immediate vicinity of the shores of the lake with cesspools and other sources of pollution within 100 feet of the water. Large quantities of sewage are disposed of upon or in the ground daily, and it is impracticable to so discharge this sewage that it will cease to be a menace to the purity of the water supply of the pond until a sewerage system has been provided.

Under the circumstances, it does not appear to the Department reasonable to provide such regulations, since their attempted enforcement would involve considerable expense and their effective enforcement is impracticable. At the present time the entire supply of the town is taken from Great Pond, but Little Pond is maintained ready for immediate use in case a breakdown in the intake pipe, the machinery at Great Pond, or any other emergency should make the use of water of Little Pond necessary. It is very desirable, under the circumstances, that the condition of Little Pond should be maintained as free from pollution as practicable, but in case it should become necessary to use the water of Little Pond it should be disinfected before use, and at the same time all of the inhabitants of the town should be warned to boil all water before using it for drinking.

In view of the danger involved in the use of Little Pond water for domestic purposes, the Department considers it highly desirable that the town shall provide an adequate supply of good drinking water and avoid the danger of the necessity of drawing water from Little Pond, but so long as the possible necessity for using water from Little Pond exists it is important that all pollution of that pond shall be avoided, so far as practicable, and the danger of injury to the health of the town from the use of this water in case of emergency reduced to a minimum.

The use of Little Pond for boating, fishing, bathing, etc., would undoubtedly be a great advantage to the inhabitants of the town, and if the town would make available an adequate supply of water from a suitable source, there would be no objection to using Little Pond for those purposes.

Under date of Oct. 21, 1916, the Department sent the following communication to the Board of Water Commissioners of Braintree in response to their letter of October 6 relative to the question of boating and fishing on Little Pond: —

It appears to this Department that, if it should make rules and regulations for the sanitary protection of Little Pond, which is maintained at present only for use in case of emergency, a number of the inhabitants about the shores of the pond would be put to considerable expense in the course of the enforcement of the regulations Under the present conditions, it does not appear to the Department reasonable to adopt this course.

Without the adoption of rules and regulations by this Department, it will be impracticable for the Department to authorize your board to regulate boating and fishing on Little Pond.

Cambridge.

After an examination of plans and specifications of proposed filtration works for filtering the water supply of the city of Cambridge, submitted by the Cambridge Water Board, the Department, on May 9, 1916, replied to the application of that Board as follows: —

These plans provide for diverting the flow of the Stony Brook conduit at a point above its entrance to Fresh Pond to mechanical filters, to be located about 500 feet west of the present pumping station, whence the filtered water will be discharged into a clear water basin, from which it will be supplied to the city by the present works. Provision is also made for pumping water from Fresh Pond to the filter plant if necessary. The water before filtration will be delivered into a coagulating basin having a capacity of about 1,500,000 gallons, prior to which the water will be treated with sulphate of alumina at the estimated rate of $\frac{3}{4}$ of a grain per gallon and possibly at times with a small quantity of soda ash. The filters shown upon the plans are fourteen in number, with a total area of 4,900 feet of sand surface, are to contain 33 inches in depth of filtering material, and are designed to have a nominal capacity of 14,000,000 gallons per day. Water cannot be constantly filtered at this rate, however, because it is necessary to suspend filtration when the filter beds are being cleaned and also occasionally for repairs. After filtration the water will pass through an aerator and thence to a clear water basin, which will have a capacity of about 4,000,000 gallons. Provision is also made for the treatment of the water previous to aeration by applying hypochlorite of lime at an estimated rate of 4 pounds per million gallons or an equivalent amount of liquid chlorine.

From the clear water basin the filtered water is to be pumped by the present pumps as at present. The force main delivers water into Payson Park Reservoir which has a nominal capacity of 43,000,000 gallons but which appears to have never been filled on account of leakage. The Department is informed that it is proposed to repair this reservoir. From the Payson Park Reservoir the water flows to the city by gravity. The main pump at Fresh Pond has a rated capacity of about 20,000,000 gallons per day and cannot be economically operated at a rate much less than this.

The plans provide for washing the filter beds with compressed air and filtered water, but the dirty wash water instead of being wasted according to the method in almost universal use where mechanical filters are employed, is to be delivered to a receiving basin and then returned to the sedimentation basin and added to the unfiltered water. At intervals the sludge is to be drawn from the sedimentation basin and allowed to flow to an existing sewer.

The sedimentation basin and clear water basin are both to be covered masonry structures, the latter being partly beneath the building which contains the filters, pumps, and various appurtenances.

The Department has given hearings to your board and its engineer, at which the proposed plans were fully explained, and has considered the information presented. At the second hearing your board suggested a modification of the proposed method of operating the filter, by which the water would always be drawn from Fresh Pond instead of from Stony Brook conduit. This was later confirmed in writing by your engineer.

The water supply of the city of Cambridge at the present time is drawn wholly from Fresh Pond, which has a limited watershed of its own but is supplied chiefly from the watershed of Stony Brook Reservoir in Waltham, Weston and Lincoln.

Stony Brook Reservoir, situated at the lower end of the watershed of Stony Brook a short distance from the Charles River, has an available storage capacity of 354,000,000 gallons and a drainage area of 23.57 square miles. This reservoir was constructed nearly thirty years ago and was prepared for the storage of water by the removal of the soil and organic matter from the area flowed. Subsequently, a reservoir having a storage capacity of 2,338,000,000 gallons was constructed on Hobbs Brook, a tributary of Stony Brook, at a point about 3½ miles above Stony Brook Reservoir. The watershed area tributary to this reservoir is 7.25 square miles, and the area flowed, amounting to 558 acres, was prepared for the storage of water in practically the same manner as the Stony Brook Reservoir.

The watershed of Stony Brook and its tributaries contains considerable areas of swamps, and the water entering the reservoirs is at times highly colored. Owing to the great capacity of Hobbs Brook Reservoir in proportion to the size of its watershed, the water of the reservoir is greatly improved by bleaching and the other beneficial effects of long storage. The average color of the lower reservoir throughout the period since it was first used, viz., from 1899 to 1915, has ranged from a minimum yearly average of .11 to a maximum of .20, the average throughout this period being .15. Water from Hobbs Brook Reservoir flows in the channel of Hobbs Brook to Stony Brook, where it mingles with water from other parts of the Stony Brook watershed before entering the Stony

Brook Reservoir, and water is drawn from Hobbs Brook Reservoir through the drier part of the year when the yield of Stony Brook Reservoir used in connection with Fresh Pond is inadequate for the requirements of the city. The water which enters Stony Brook Reservoir is usually highly colored, though the color is materially reduced when considerable quantities of water are flowing from Hobbs Brook Reservoir, especially in the drier part of the year when the yield of Stony Brook is comparatively small. The storage in Stony Brook Reservoir materially improves the water which enters it, but the storage is not long enough, on account of the comparatively limited capacity of this reservoir, to effect the great improvement which is produced upon the water stored in the larger Hobbs Brook Reservoir.

In consequence of these conditions, the water delivered from Stony Brook Reservoir to Fresh Pond is variable in character, the color ranging from a minimum of .10, when the supply is being drawn chiefly from Hobbs Brook, to a maximum of slightly over 1.00 when the yield is derived principally from the Stony Brook watershed. The average color of the water of Stony Brook Reservoir during the same period of years as that covered by the observations at Hobbs Brook, viz., 1899 to 1915, has ranged from a minimum yearly average of .28 to a maximum of .55, the average throughout this period having been .41.

Fresh Pond has a storage capacity of 1,600,000,000 gallons and, as already stated, is supplied chiefly from Stony Brook, though it receives some water also from a tributary drainage area estimated at somewhat less than a square mile. Much of this water is derived from populous districts and enters the pond by infiltration through the ground. While the quantity of this water is small, it probably contains considerable amounts of nitrates and is very likely one of the chief causes of the growth of microscopic organisms in the water of Fresh Pond. The presence of these organisms in the water, so far as known, has no injurious effect upon the health of those using it, but they impart to the water a noticeable and sometimes unpleasant taste and odor and at times a noticeable turbidity. These growths of algae and other microscopic organisms are not only large in amount but they appear to have been gradually increasing in recent years, especially during the warm seasons. This is shown not only by the microscopical examinations of samples of water from Fresh Pond but also from the determinations of free ammonia and total and suspended albuminoid ammonia.

It is probable that such growths in Fresh Pond would be reduced if the water from its natural tributary watershed could be cut off. Such a scheme, while no doubt practicable with properly designed works, would be unduly expensive. The application of copper sulphate to the water of Fresh Pond would also reduce the algae growths, but this would be but a palliative treatment. This Department is of the opinion that the best method of removing the microscopic organisms and their odors is by aeration and filtration.

The water of Stony Brook is discharged into Fresh Pond at an inlet located near the head of one of the larger coves. The intake pipe at the pumping station through which the water is drawn for the supply of the city is located at the head of another cove, and the arrangement is such that water from Stony Brook cannot pass directly across the pond to the intake but must reach the intake by a circuitous course. This insures long storage to all of the water in the pond.

The storage of Stony Brook water in Fresh Pond reduces the color of the water so that the yearly averages of the color of the water drawn from Fresh Pond in the period above referred to, 1899 to 1915, ranged from .15 to .32 and has averaged about .23. In this period none of the samples of water from Fresh Pond examined at the laboratory of this Department has had a color exceeding .40, and the color has exceeded .30 in only about 15 per cent. of the samples examined, while two-thirds of all the samples examined in this period have had a color of .25 or less. The average color of the water of Stony Brook entering Fresh Pond during this entire period was .41, while the average color of the water in the pond itself was .23, or 56 per cent. of that of the water which enters it through the Stony Brook conduit. As the consumption of water increases and the time of storage of the water becomes less, the color of the water supplied to the city will tend to increase.

The watershed of Stony Brook contains a considerable population and the waters of some of the tributaries of that source are exposed to danger of pollution by wastes from the population living within the drainage area. The watershed has been subject to inspection, however, by your board during all of the years of its use, and there is no marked indication, judging from the examinations made by this Department, that there has been a serious increase in the pollution of the water up to the present time. There has been, however, a slight increase in the total solids, chlorine, free and albuminoid ammonia during the last ten or fifteen years, due probably to the increasing population on the watershed.

The long storage of the water in Fresh Pond has a most beneficial effect upon its hygienic quality, yet it is possible that the population on the watershed may increase to such an extent in the future as to make the adequate protection of these sources difficult and filtration necessary for hygienic reasons.

A comparison of the mortality statistics of Cambridge with those of other cities in the State shows that in the five years ending with 1914 deaths from typhoid fever have been less in Cambridge in proportion to the population than in any of the other cities of the State having in 1915 a population in excess of 40,000, with the exception of the city of Malden. Bearing in mind the considerable population on the watershed of Stony Brook, the effect of the storage in Fresh Pond as a means of purifying the water and protecting the health of the inhabitants of the city of Cambridge is made evident.

Average Death Rate from Typhoid Fever in the Five Years From 1910 to 1914, inclusive, in the Cities of Massachusetts having a Population in 1915 in Excess of 40,000.

City.	Death Rate per 100,000.	City.	Death Rate per 100,000.
Malden,	4.8	Lowell,	12.0
Cambridge,	5.6	Chelsea,	12.5
Newton,	5.9	Fall River,	12.5
Brockton,	6.4	Lawrence,	12.8
Quincy,	6.7	Haverhill,	13.9
Worcester,	6.8	New Bedford,	17.3
Somerville,	7.7	Lynn,	18.2
Holyoke,	7.8	Springfield,	18.6
Boston,	9.2		

In view of the great value of Fresh Pond in the bacterial purification of the water supply of the city of Cambridge which has thus been demonstrated, this Department is of the opinion that no method of improving the quality of the water should be introduced which would involve the discontinuance of the use of Fresh Pond, and is unable to find that the method of drawing the supply directly from the Stony Brook conduit and filtering it, as first proposed by your engineer, would increase the protection of the health of the people of Cambridge. If it is decided to filter the water, this should be done after and not before storage in Fresh Pond. Filtration after storage would double the hygienic protection of the supply and not merely substitute one method for another.

The evidence at hand appears to indicate that filtration by itself will not make the water entirely clear as it reaches the consumers. At present the water as it flows from the faucets in the city is at times objectionably turbid and colored, due to the stirring up of material deposited in the mains in past years, to iron rust from the pipes and to growths of pipe moss. The pipes should be cleaned without delay under competent engineering supervision. If properly done, this should effect a marked improvement in the quality of the water supply of the city.

This Department is of the opinion that filtration of the water after passing through Fresh Pond, together with aeration and a thorough cleaning of the city mains, is the only practicable method of reducing the turbidity, color, taste and odor to negligible amounts.

The plans submitted to the Department provide for the method of filtration known as mechanical filtration, and involve the use of chemicals, — namely, sulphate of alumina, commonly known as alum, at all times, and occasionally soda ash. Provision is also made for the disinfection of the filtered water with calcium hypochlorite or liquid chlorine. According to the statement of your engineer, the method of sand filtration of Fresh Pond water without the use of chemicals was not investigated by him in any detailed way.

Careful consideration has been given by this Department to the relative merits and demerits of the two systems of filtration as applied to the purification of the water of Fresh Pond and it is the opinion of the Department that either method, if properly operated, will satisfactorily remove bacteria, turbidity and, if accompanied by aeration, the tastes and odors of the water. Mechanical filtration will give the greater decolorization, but will alter the hardness of the water so as to make it somewhat less satisfactory for manufacturing use and for boiler purposes; further it will tend to make the filtered water more liable to corrode metallic substances and thus tend to shorten the life of pipes, tanks and plumbing fixtures in house installations unless a long period of coagulation prior to filtration, and vigorous aeration after filtration or the addition of lime, be provided for. The addition of lime would of course increase the hardness of the water.

Sand filtration without the use of chemicals will also reduce the color of the water enough to make it acceptable to the consumers, but will not decolorize the water as completely as the method of mechanical filtration. On the other hand it will not alter the hardness of the water and will not, to so great an extent, cause the water to act on pipes, tanks and plumbing fixtures. According to the proposed plans the filtered water is to be pumped into Payson Park Reservoir, which has a nominal storage period with its present consumption of four days, before it flows to the city. There will probably be some danger that growths of microscopic organisms may develop in the filtered water in this reservoir, and the chance of such growths will be somewhat greater if the water is chemically treated as proposed.

It is the opinion of this Department that the differences between the results to be obtained by the purification of the Fresh Pond water by sand filtration and by mechanical filtration are not sufficient to debar the use of either method if that method should prove to be decidedly advantageous from the standpoint of cost and maintenance.

The estimates of the cost of filtration submitted to this Department are based on the filtration of water from the Stony Brook conduit and not upon the filtration of water from Fresh Pond. Furthermore, the estimates of cost submitted by your engineer do not appear to be complete in all respects.

This Department is unable to advise the adoption of the plans submitted by your Board for the following reasons among others: —

First. — The plans do not provide for taking water regularly from Fresh Pond, but from the Stony Brook conduit.

Second. — The sedimentation basin is not large enough to allow a sufficiently long period of coagulation prior to filtration.

Third. — The clear water basin is not of sufficient size to allow the main pump to operate at an advantageous rate during such periods of high consumption lasting for several days as are likely to occur one or more times each year.

Fourth. — The size of the filter plant will not be sufficient to supply water to the city when the consumption shall have reached the capacity of the Cambridge water works. With the normal increase in consumption due to growth in population the filter would have to be enlarged in about fifteen years. The plans do not make provision for such enlargement in the future, and it is not evident to this Department how such enlargement could be economically constructed.

Fifth. — The return of the dirty wash water to the sedimentation basin is objectionable.

In view of the probability that Cambridge will ultimately find it necessary to join the metropolitan water district in order to obtain a sufficient supply of water for future needs, the question of the advisability and possible advantages to the city of joining the district at the present time or in the near future requires careful consideration in connection with the proposed expenditures for the filtration of the water, for the reason that a fair estimate of the cost and maintenance of the filter plant cannot be made apart from the useful life of the plant.

From the reports of engineers employed by the city a few years ago it appears that your present sources are capable of yielding about 11,500,000 gallons per day if a portion of the conduit leading from Stony Brook Reservoir to Fresh Pond is enlarged; while 14,400,000 gallons a day can be obtained by pumping back the overflow from Stony Brook Reservoir in sufficient quantity to insure the filling of Hobbs Brook Reservoir each spring. Further increase in the development of this watershed appears to be impracticable, and when the capacity indicated has been reached a supply from some other source will become necessary.

The estimates of cost presented by your engineers indicate that the cost of the works for enlarging the supply to 14,400,000 gallons per day would amount to a total of $480,000. At the rate of increase in the consumption of water which prevailed up to 1912, the maximum capacity of your sources would have been reached in a very few years. The consumption has recently been materially reduced, however, especially during the past year, by means of inspection. By the general metering of all of the services of the city this reduction in the waste of water can be made permanent. Hence a supply of 11,500,000 gallons per day will probably be adequate until about the year 1933, and if further development is made to a capacity of 14,400,000 gallons per day, the supply will be sufficient for the next thirty-five years, provided the growth of the city continues at approximately the same rate as in past years and the waste of water is restricted by the use of meters. At the end of this time the securing of a supplementary supply is likely to be difficult and costly even if practicable, and it is probable that the city will find it necessary, when the capacity of its works has been reached, to join the metropolitan water district and secure its supply thereafter from that source.

Under existing laws there are two general plans by which Cambridge can join the metropolitan district and secure a right to a water supply from that source; one by abandoning the use of its present works and taking its full supply from the metropolitan water system; and the other, by paying the assessment required for admission to the district and the annual assessment for the water it uses, but continuing to use its own works and receiving a rebate for a fixed amount of water supplied therefrom.

It appears to this Department desirable that the city of Cambridge shall continue to use its present sources as long as they are capable of furnishing water of good quality and in adequate quantity for its requirements. But it is also important that the city shall adopt a plan which will insure it an adequate water supply for the future in the most economical way. It is practicable, as already indicated, for the city to increase the yield of its present sources to about 14,400,000 gallons per day, as an ultimate limit, and the cost of such a development would be in the neighborhood of $500,000, in addition to which there would be a considerable annual cost for maintenance.

When the above-mentioned limit of Cambridge supply shall have been reached, there is no likelihood that any other source can at that time be found from which water can be obtained as economically as from the metropolitan water district, and the entrance of the city of Cambridge into the metropolitan water district would appear to be only a question of time. Sooner or later, therefore, when the capacity of the present sources has been reached and an additional supply becomes necessary, a great expense must undoubtedly be incurred by the city for another source of supply. There are in general two courses now open to the city by which it may provide for its future needs when additional water is required; one is to wait until the additional supply becomes immediately necessary and at that time provide for the payment which will be required; and the other is for the city to begin at once to pay for the future additional water supply by means of comparatively small annual payments, which by the time the supply is needed will be adequate to provide for it without the necessity of increasing the water rates at any time.

It appears to the Department that, if the necessary legislation can be secured, a reasonable way may be found whereby Cambridge can enter the metropolitan water district at the present time or in the near future under an arrangement which will be advantageous to the city and satisfactory to the district at a smaller annual cost to Cambridge than by any plan now available. The agreement made between the Metropolitan Water Board and the city of Newton furnishes a precedent for such an arrangement which it would be wise to consider.

In looking forward to a future supply from the metropolitan water district it should be considered that the time will come when the cost of delivering water by gravity from the great storage reservoir at Wachusett will be less than the cost of pumping and supplying water from Fresh Pond.

In view of the foregoing facts the State Department of Health advises that the proposed plan of the Cambridge Water Board for the purification of the water supply of the city by the method of mechanical filtration be revised. It also recommends that before adopting any plan for the purification of the Cambridge water a careful study be made of the feasibility, advantages and cost of slow sand filtration for comparison with a revised plan for mechanical filtration. It further recommends that the Cambridge Water Board consider the best arrangement to be made with the Metropolitan Water Board for taking water from the metropolitan works at some time in the near future along the lines above described, together with any legislation which may be needed in connection therewith.

This Department will, if you so request, assist you, as far as it may, in further investigations, in order that the city may secure the best practicable method of improving the quality of its water supply and providing for its future needs. If revised estimates of cost are submitted it would be a convenience to this Department and facilitate its recommendations if such estimates could be submitted in detail.

In reply to a communication of the Cambridge Water Board, dated Sept. 15, 1916, requesting the approval by this Department of certain filtration plans, the Department, after consulting the Attorney-General, found that there is no provision in the statutes for such approval and so notified the Cambridge Water Board on Dec. 11, 1916.

Cummington.

In reply to an application from the Board of Water Commissioners of the town of Cummington for approval of plans for a system of water supply to be taken from certain wells northwest of the village, the Department, on Jan. 25, 1916, advised as follows: —

The results of the analyses show that the water of these wells, while somewhat hard, is of good quality for drinking and domestic use.

Regarding the quantity of water that can be made available in the locality in which the wells are situated, no definite statement can be given since no accurate test has yet been made to determine the probable yield of the wells. It is said, however, that the wells were sunk to a depth of about 25 feet through impervious material to coarse gravel and yielded water freely. The wells thus far put in are three in number, located about 50 feet apart and about 25 feet from the river. They are to be connected with a pipe which leads to a fourth well located below the dam which crosses the river in this neighborhood. This latter well is 10 feet in diameter and about seven feet in depth, with a tubular well in its bottom similar to the others. From this collecting well the water is to be pumped to the distributing reservoir having a capacity of 80,000 gallons, and thence supplied to the town. It appears that the ground in which the wells are located is subject to flooding at times of high water in the river, but it is proposed to provide tight covers over these wells in order to prevent danger of contamination by the river water. It appears that a direct connection with the river for use in case of fire has also been provided.

The Department has considered the plans and is of the opinion that water obtained from these wells is likely to be of good quality for drinking and that the quantity is likely to be sufficient for the requirements of the town. The

Department does not approve, however, of the direct connection with the river on account of the danger that polluted water may be drawn into the system in case of fire and injury to the health of the inhabitants result therefrom. The Department recommends that this connection be removed as soon as practicable. Until such connection is removed, the Department will be unable to approve the plans presented.

It is further suggested that, in view of the fact that the pumping is to be done in a factory where the works might be rendered inoperative in case of fire or accident, it will be desirable, as soon as practicable, to provide an auxiliary pump located in the neighborhood of the wells which could be used in case of emergency.

DUNSTABLE.

In response to a request from the Water Supply Committee of the town of Dunstable for advice as to certain sources of water supply for the town, the Department, after an examination of the various sources under consideration, gave the following advice under date of June 12, 1916: —

The most favorable source of those presented, as determined by your engineer, is a ground-water supply to be obtained from a well on the southerly side of a small mill-pond on Black Brook about ¼ of a mile southwest of the center of the village, and a test pit has been dug on the southerly shore of this pond from which it has been practicable to obtain a sample of water for analysis.

The results of the analysis show that the ground water in this region is likely to be very soft, free from iron, and in all respects of excellent quality for the purposes of a public water supply. There is considerable porous soil in the region about the southerly shore of this pond, judging from the surface indications and the information furnished by the test pit, and it is probable that an adequate quantity of water for all of the requirements of the village could be secured at all times from a suitable well in this region. It is probable that the best form of collecting works would be a well of rectangular section and considerable length constructed parallel to the shore of the pond and 20 feet or more therefrom, with its bottom 2 feet or more below the level at which the water in the pond stands in the drier part of the year.

Another location has been suggested as an alternative source of ground-water supply in case the source above described should not prove satisfactory or desirable. This alternative location is situated about ¼ of a mile east of the test pit already examined near the junction of the two tributaries of Black Brook which unite above the pond. A sample of water from a spring in this location indicates that the ground water in this region is somewhat harder than in the neighborhood of the test pit, and there are indications also that the water in the neighborhood of the junction of the brooks may be affected somewhat by iron. Judging from the investigations thus far made, the Department is of the opinion that the most appropriate method of providing a water supply for the town of Dunstable will be to take water from the ground by means of a suitable well on the southerly side of the pond on Black Brook in the neighborhood of the test pit already located there but at a somewhat greater distance from the pond.

If you decide to locate collecting works in this region, it would be advisable, after the excavation for the well is made and before further work is done, to test the probable quantity and quality of water obtainable therefrom, and, if you so request, this Department will assist you in these investigations.

EASTON (NORTH EASTON).

In response to a request from the Board of Health of Easton, through the State District Health Officer, for an examination of well No. 2 of the North Easton Village District, the Department made the following reply on March 27, 1916: —

The results of the recent analysis show that the water entering this well has at some time been polluted but subsequently thoroughly purified in its passage through the ground, and at the time of this examination the water was undoubtedly safe for drinking.

The well appears to have been sunk in rock, and it is not possible to tell under the circumstances whether the quality of the water will remain satisfactory if used continuously as a source of water supply for the town or whether its quality will deteriorate. Under the circumstances, it is important that samples of the water be analyzed from time to time in order that any serious deterioration may be detected and prevented, if practicable, or the use of the well discontinued.

FALL RIVER.

On Jan. 11, 1916, the Department issued the following order relative to the cutting of ice on North Watuppa Pond, the source of water supply of the city of Fall River: —

Acting under the authority of Section 113 of Chapter 75 of the Revised Laws, as amended by Section 1 of Chapter 467 of the Acts of 1907, in order to prevent the pollution and secure the sanitary protection of the waters of North Watuppa Pond, the State Department of Health hereby orders that no ice shall hereafter be cut on said pond, a source of water supply of the city of Fall River.

Attention is called to the following provisions of Section 122 of Chapter 75 of the Revised Laws:

> Whoever violates any rule, regulation or order made under the provisions of section one hundred and thirteen or one hundred and eighteen shall be punished for each offence by a fine of not more than five hundred dollars, to the use of the commonwealth, or by imprisonment for not more than one year, or by both such fine and imprisonment.

An application was received from the Reservoir Commission of the city of Fall River on Feb. 23, 1916, requesting the advice of the Department as to a plan for diverting the water of Brightman's Cove and its watershed into the intercepting drain along the westerly side of the pond and thence into the South Pond, thus reducing the drainage area of North Watuppa Pond, the water supply of the city. The scheme is outlined in a report of the engineer of the commission presented with the application. Regarding this scheme the Department advised on March 13, 1916, as follows: —

> In this report the scheme, which is described as a compromise to avoid litigation over water rights in Highland Brook and the ownership of Brightman's Cove, is outlined as follows: —
>
> > The City to release its claim to Brightman's Cove.
> >
> > Mrs. Borden to build a tight causeway or dam near the site of the present causeway to prevent any passage of water to or from the North Pond, to install, maintain and operate a pump or other suitable device for lifting water from drainage ditches in the Cove into the intercepting drain.
> >
> > The City to further permit Mrs. Borden to construct a pipe or conduit across its land to connect the drainage pump on her land with the intercepting drain, and allow water to be pumped therein.
> >
> > While this suggestion is at present in tentative form only it raises the general question of the advisability of a different method of treatment of Brightman's Cove and Interlachen from that of the City acquiring all of this territory, and whether such treatment would meet with the approval of the State Department of Health.
>
> From the information presented in the report submitted, it appears that Brightman's Cove, between the causeway at its outlet and the intercepting drain which passes west of the upper end of the cove, has an area of 26 acres at full pond level of the North Watuppa Pond and a drainage area of 45 acres, making the total area to be diverted from North Watuppa Pond about 71 acres. It further appears that when North Watuppa Pond is full, viz., when the water stands at elevation 129.42, the depth of water in Brightman's Cove is 2 feet near the causeway and about one foot at the upper end, with a deeper pool at one place, presumably in the upper part of the cove, maintained by a ridge of land slightly lower than full pond level. The lands along the northwesterly side of the cove are apparently all owned by the city of Fall River, with the exception of two small parcels, one having an area of 1.15 acres located at the mouth of Highland Brook, and the other an area of 3.41 acres located northeast of the smaller parcel.
>
> The drainage area along the southeasterly side of the cove comprises a part of the peninsula of Interlachen, and these lands have not yet been acquired by the city. There are no buildings within the watershed of Brightman's Cove, as shown on the plan submitted with the report, excepting a portion of a barn situated near the southerly end of the causeway near the mouth of the cove.
>
> The engineer further states: —
>
> > The scheme suggested by counsel for Effie B. Borden if carried out would divert to the intercepting drain, with little or no cost to the City, all drainage from the area enclosed by the yellow dotted line on the plan — about 71 acres — which includes a considerable portion of Interlachen.

The taking of Interlachen by the City under these circumstances could probably be deferred many years, if not indefinitely. In any event it would not be necessary to take the portion of Interlachen draining directly into Brightman's Cove. The City could also, if desirable, dispose of such lands as it has acquired within the 71 acres draining into the Cove, and the two parcels "A", northwest of the Cove, as well as "C", would not be needed by the City.

To offset the above advantages would be the loss of water supply from 45 acres of land and 26 acres of the Cove which is swampy, and at times flooded, and from which there is considerable evaporation loss. The storage capacity in the Cove is at present very small on account of its shallow depth. The mud deposits and other objectionable features as regards storage of water for municipal use would also have to be removed at considerable expense, so that it seems fair to consider the value of the storage afforded by the Cove as negligible.

The State Department of Health has carefully considered the scheme submitted and has examined the plan presented therewith. From this plan it appears that the only building of any kind within the watershed now draining into Brightman's Cove is a portion of a barn situated near the causeway at its outer end, which does not appear to be a source of serious danger to the purity of the water either in the cove or the pond at the present time. The pollution which the cove formerly received through Highland Brook has now been diverted into the intercepting drain, and any objectionable deposits in the cove brought down by the brook in past times can apparently be disposed of and the condition of the cove made unobjectionable without serious difficulty or expense.

Under the circumstances, the Department is unable to find that the cove is exposed to any serious danger of pollution at the present time or that its condition is such as to require the diversion of its waters to the intercepting drain. The other advantages mentioned for this scheme are the avoidance of a possible law suit over claims to riparian rights in Highland Brook on account of the acquisition by the city of a small parcel of land marked *A* on the plan presented and the settlement of a claim relating to ownership of Brightman's Cove which, so far as appears from the report of your engineer, has no reasonable basis. On the other hand, it appears to the Department that the acceptance of the proposed plan would involve serious losses and disadvantages to the city of Fall River. The losses to the city would be (1) the reduction of the watershed of North Watuppa Pond, (2) the reduction of the capacity of the intercepting drain already completed, and (3) the loss of value of lands already acquired by the city within the watershed of Brightman's Cove, so far as the protection of the water supply is concerned.

Furthermore, the cost of pumping all of the flow of water from Brightman's Cove and its drainage area to the intercepting drain at all times is likely to involve a considerable expense, even if carried out in the most economical way, by utilizing the storage in the cove at times of very high flow in order to reduce the cost of the works necessary for the purpose, and the continued maintenance of such works for any very considerable time in the future seems doubtful.

Finally, the plan would not in any way reduce any danger of pollution of

North Watuppa Pond from the buildings on the peninsula of Interlachen except such as might be caused by the portion of the barn within the watershed of Brightman's Cove already mentioned.

North Watuppa Pond will doubtless continue for a great many years, so far as can now be foreseen, to be the principal source of water supply and the chief storage reservoir of the city of Fall River, and it is desirable that the city should control this pond and its surroundings completely so as to protect it effectively from danger of pollution. The policy of acquiring the land within the watershed of this pond has been followed for many years, and the city now owns a very large portion of its watershed. Furthermore, the city of Fall River has recently incurred a large expense in the construction of a conduit to divert the water from all of the polluted areas on the westerly side of the pond, and there remains only the diversion of a small area on its easterly side to remove nearly all the existing pollutions from this watershed. For the city now to reverse its policy and divest itself of any lands which it has already acquired for the purpose of the protection of this water supply appears to the Department a serious mistake.

Hamilton.

On Dec. 13, 1915, the Department received an application from the Water Supply Committee of the town of Hamilton for advice relative to two plans for a water-works system for the town, by one of which the town would be supplied from an independent source, and by the other from the sources used by the cities of Salem and Beverly. Concerning these two plans the Department gave the following advice on Jan. 20, 1916: —

In the course of the investigations for an independent supply, tests have been made at various localities in the town with a view to obtaining water from the ground, these localities including the low ground south of Vineyard Hill in the extreme westerly part of the town, the valley of Black Brook about half a mile north of the Boston and Maine Railroad, the valley of Miles River in the region extending for about a mile north of Hamilton station, and the valley of a tributary of Miles River from the south a little over half a mile east of Hamilton station.

The ground water in the valley south of Vineyard Hill was found to be excessively hard, and the water in the valley of Black Brook was also found to be so hard as to make it undesirable for domestic use. The water of the wells in the valley of Miles River was clear, colorless, odorless and in most other respects of excellent quality for water supply purposes, but this water also was so excessively hard as to make it objectionable for the purposes of a public water supply.

The tests in the region east of the Hamilton station were made not far from the location in which a test was made fifteen years ago when the question of a water supply for Hamilton was under consideration. The further tests in this region consisted in the sinking of nineteen test wells in an area about 700 feet long by 100 feet in width on the easterly side of Miles River in the valley of a very small tributary which joins that stream from the east. Practically all of these wells were driven to a stratum of coarse sand or gravel and yielded water very freely when pumped from with a hand pump.

The analyses of a sample of water from one of these wells, of samples from a test well driven several years ago, and from a natural spring indicate that the ground water in this region is of good quality for domestic use. These tests are sufficiently favorable to warrant the expectation that an adequate quantity of water of good quality for domestic use could be obtained from the ground in the location in which these tests were made. It is advisable, however, before locating permanent works for obtaining a water supply in this region, that a further test be made by connecting together a group of wells and pumping from them continuously for a period of two or three weeks to determine more definitely the probable quantity of water obtainable and to determine also whether there is any probability that the quality of the water would change if the quantity required for the supply of Hamilton should be drawn continuously from the ground in this region. Owing to the excessive and very unusual rainfall of the past summer, such a test was impracticable, but it is advisable that it be made before it is decided to locate works in this region for obtaining a water supply for the town.

Your engineer has also considered a plan for supplying the town with water from the sources used by Salem and Beverly, the water to be delivered at the Wenham-Hamilton boundary line through a pipe line connected with the new reservoir on Folly Hill. There is no doubt that an adequate supply of water can be supplied to the town of Hamilton from the Salem and Beverly sources, assuming of course that suitable works are provided for the purpose, and there is no doubt that a water suitable for domestic use could be obtained in that way, though its quality would not be equal to the natural ground water in the region east of Hamilton station, if the quality of the latter should remain as satisfactory as that shown by the tests recently made in that region.

The cost of a water supply from the Salem and Beverly sources, as compared with that from an independent source in the region east of Hamilton station, has been considered by your engineer, on the basis of certain estimates of the cost of water from the sources of Salem and Beverly and the probable charge therefor. Upon the basis of these estimates, the cost of obtaining a supply from independent works within the town of Hamilton would be somewhat greater than from the Salem and Beverly sources, though the difference is not large. In view, however, of the better quality of water that may be obtained from the ground in the region east of Hamilton station, that source would probably prove to be the more satisfactory for the town to adopt, if the difference in cost is not large.

In view of the circumstances, it is advisable, in the opinion of the Department, for the town of Hamilton to determine definitely whether an adequate supply of good water can be obtained from the ground in the region east of Hamilton station by making a thorough pumping test from a group of wells in that region, and this test should be made as soon as practicable during the coming summer. It is also advisable in the meantime that the terms upon which water can be obtained from Salem and Beverly and the cost of works for such a system be definitely ascertained.

When the results of the further tests herein suggested and the further negotiations with Salem and Beverly are available, the Department will give you further advice in this matter, if you so request.

Ipswich.

On March 14, 1916, the Department received an application signed by several citizens of Ipswich requesting its opinion as to the quality of the Ipswich water supply in connection with a proposed extension of the supply, to which the Department, on May 3, 1916, replied as follows: —

The water at the present time is taken from Dow's Brook Reservoir, an artificial basin on Dow's Brook, and is pumped into the supply mains of the town, — a reservoir on Town Hill being used in connection with the distribution system. The greater part of the watershed of Dow's Brook is uninhabited and the chief danger of pollution to which this source is exposed is due to the presence of a number of dwelling houses on the northeasterly side of the reservoir along the road leading from Ipswich to Rowley, drainage from the neighborhood of which flows naturally into the reservoir or into small tributary streams in this region.

Recent examinations of the reservoir and the streams which enter it did not show evidence of serious pollution at the time the examinations were made, and there is no indication that the water of the reservoir has thus far been injuriously polluted from the dwellings on the watershed. The chief danger from present conditions about this reservoir would occur at a time of heavy rain when the reservoir is drawn down to a low level and the period of storage materially reduced. Under present conditions the water is safe for drinking, but the dwelling houses and lands along the northeasterly side of the reservoir which are so located as to be a menace to the purity of the water should be acquired by the town, as repeatedly recommended by the board of water commissioners. This improvement can be made at less expense if undertaken in the near future before the number of buildings increases.

The water of Bull Brook has been used on one occasion to supplement the water of Dow's Brook when the reservoir had been drawn to a low level. The watershed of Bull Brook contains very few buildings, all of which are located near its outer limits, and although the water is highly colored, the source under present conditions is a safe one from which to take a supplementary water supply whenever such a supply becomes necessary.

LEOMINSTER.

In response to a request from the Water Board of Leominster for a special examination of the waters of Haynes and Morse reservoirs, and advice concerning their quality, the Department caused the examination to be made, and on Jan. 20, 1916, advised the Water Board as follows: —

The results of these examinations show that the waters of these reservoirs contained in the late summer and through the autumn an excessive growth of organisms, chiefly the organism *Anabœna,* which when present in considerable numbers in the waters of ponds and reservoirs imparts to the water a very disagreeable taste and odor. This organism has appeared in these reservoirs at frequent intervals ever since they were first examined by this Department, appearing usually in the Haynes Reservoir and subsequently in the Morse Reservoir, to which the water of Haynes Reservoir is largely supplied. The recent analyses show that the objectionable organisms have now disappeared from these reservoirs and their waters will now be unobjectionable for use until a new growth appears.

It appears from the information available to the Department that Haynes Reservoir has an area of about 58 acres and holds about 140 million gallons. The reservoir, which was constructed more than 40 years ago, is very shallow, having an average depth of about 7.3 feet, and appears to have received no preparation for the purpose other than the removal of trees and brush until quite recently, when all of the stumps were finally removed from the area flowed. The bottom of the reservoir, however, apparently still contains a large quantity of organic matter, extending in some places to a considerable depth. The reservoir has a watershed area of about .5 of a square mile which contains very few buildings, none of which are located in the immediate neighborhood of the reservoir.

The Morse Reservoir has an area of 13.6 acres, a capacity of a little over 48 million gallons, and an average depth of 11 feet. It is fed in part by a direct drainage area of .56 of a square mile and in part with the water from Haynes Reservoir, all of which flows into Morse Reservoir, except at periods of high flow when a part of the water from that source flows directly to the distributing reservoir. The Morse Reservoir appears to have been properly cleaned and prepared for the storage of water many years ago.

The cause of the appearance and growth of microscopic organisms in ponds and reservoirs is not definitely known, but they are found most abundantly in the waters of reservoirs affected by pollution or derived from swampy drainage areas, and especially in those in which a large quantity of organic matter is present in the bottom of the reservoir. It is probable that the cause of the poor quality of the water of Haynes Reservoir, which has been notable ever since this basin was constructed, is the presence of a large quantity of organic matter in its bottom. Experience has shown that the excessive growths of organisms which take place in such reservoirs can be greatly reduced and the objectionable effect which they produce upon the quality of the water practically eliminated by removing the organic matter from the bottom of the reservoir or by covering it effectively so as to prevent it from coming in contact with the water.

It is not practicable to determine without a careful examination when the reservoir is drawn down whether it is feasible to improve the condition of Haynes Reservoir by either of the methods commonly practiced in the construction of reservoirs for the storage of water for domestic use. In order to determine definitely the best method of treating this reservoir, it is necessary that the reservoir shall be emptied, the bottom drained, and the amount of organic matter requiring removal determined from an examination of samples of soil collected from different parts of the basin. If the amount of material requiring removal is not excessive, the best plan of improving this reservoir will probably be to remove the objectionable material which, if deposited in the shallow places along the shores and covered with clean sand or gravel, will not cause further trouble. If the quantity is so great as to make the cost of removal excessive, the question of covering it effectually should be carefully considered. On account of the large area of the reservoir, however, any method of treatment may be found to be expensive.

It would be possible to purify the water of this reservoir by filtration, but the cost of such treatment would be large, and it would be a very difficult water to purify at times when affected by excessive growths of organisms such as was the case during the past summer and autumn. If filtration were desirable, it would probably be best to filter the water at the outlet of the distributing reservoir, but even under those conditions filtration would be difficult at times when the waters of the storage reservoirs are affected by excessive growths of organisms, since the water drawn from the distributing reservoir is necessarily supplied almost wholly from the storage reservoirs in the period of the year when those waters are often affected by excessive organic growths.

Considering all of the circumstances, the Department recommends that you cause Haynes Reservoir to be drawn off at the earliest practicable time and the character of the material on its bottom determined by analysis. This Department will assist you in this investigation, if you so request, by making the necessary analyses of the material found at the bottom of the reservoir and will give you further advice as to the treatment of this reservoir when the results of this investigation are available. It would be advisable, in any case, during the coming summer, if Haynes Reservoir is still in use, to draw this reservoir down in the early part of the season before the water begins to be affected by excessive organic growths, usually in late July or early August, and to discontinue its use thereafter until the excessive organic growths have disappeared, and it would be desirable in any case until the reservoir is improved to discontinue the connection by which the water of this reservoir is diverted into the Morse Reservoir.

The Department further recommends that Venturi meters be introduced on the supply mains leading from the reservoirs to the city and the quantity of water used accurately recorded. Definite information as to the quantity of water supplied to the city will be of value in considering the question of the treatment of Haynes Reservoir and also with reference to providing for the future water supply of the city.

PEABODY.

The Commission of Public Works of the town of Peabody applied to the Department on Dec. 15, 1915, for its advice and approval, under the provisions of chapter 698 of the Acts of the year 1913, of the taking of certain lands for the protection of the purity of the water of the reservoir, so called, in Peabody. These lands comprised eight parcels situated along the west side of the reservoir, and the Department, after investigation, found that the acquisition by the town of these lands was necessary for the protection of its water supply. The Department approved the taking on Jan. 11, 1916.

Subsequently, on February 18, 1916, the Department approved the taking of a parcel of land near Spring Pond, upon application by the Commission of Public Works of Peabody, the Department having found, upon examination, that the control of this land was necessary for the protection of the water supply of the town.

On June 28, 1916, the Department sent the following reply to a request from the Commission of Public Works of Peabody for advice as to the advisability of granting permits for fishing in Brown's Pond:

> The water overflowing from Brown's Pond at the present time flows naturally into a channel leading from Spring Pond to the Reservoir, so called. Moreover, water is at times drawn from Brown's Pond and Spring Pond. In consequence, it is important, in the opinion of the Department, that the waters of Brown's Pond be kept free from pollution. The granting of permits for fishing on this pond would involve considerable danger of pollution of its waters and of the waters into which they flow and, under the circumstances, the Department recommends that, while conditions remain as at present, no fishing or boating at Brown's Pond be permitted.

SALEM AND BEVERLY.

On Nov. 7, 1916, an application was received from the Salem and Beverly Water Supply Board requesting approval by the Department of a scheme for improving certain low-lying swamp areas between Wenham Lake and Cherry Street in Wenham, accompanied by a plan of the proposed works. Under date of Dec. 12, 1916, the Department replied as follows: —

> The swamps to be improved are divided naturally into three parts, all of which are located at the northerly end of Wenham Lake in the vicinity of

Cedar Street. The most northerly of the three swamps has an area of 7 or 8 acres and is located at a distance of 700 to 1,400 feet north from Cedar Street and at an elevation about 10 feet above high-water level in Wenham Lake. For the improvement of this swamp it is proposed to excavate a main ditch running approximately through the center of the swamp with tributary ditches spaced 80 to 90 feet apart on centers. The outlet of the main drain of this swamp will discharge upon the land lying to the south.

Immediately south of the swamp just described and directly bordering on the northerly side of Cedar Street are two small swampy areas, the surfaces of which are very near the same elevation as high-water level in Wenham Lake. It is proposed to lay tile drains beneath the surface of these swamps and then cover them to a depth of a foot, more or less, with gravelly material secured from the higher grounds immediately adjoining. The main drain of the most westerly of these two swamps will discharge directly into Wenham Lake at a point close to the outlet of the conduit leading from Ipswich River. The main drain of the easterly of these two swamps will discharge into a low area located south of Cedar Street and east of the ice house of the Wenham Lake Ice Company. The surface of the covering of these two swamp areas is to be so graded as to facilitate the removal of the water flowing onto them from the surrounding higher lands, and provision is to be made in grading the most easterly area for the prompt removal of the water flowing from the higher swamp to the north, already described, which will drain naturally over this area to Wenham Lake.

The treatment proposed for the small swampy area south of Cedar Street and east of the ice house is to cut away the dike to an elevation as low as the prevailing bottom elevation of the area, using the material of the dike as far as it will go in filling the low parts of the area. The lower portion of this area below grade 25 is to be filled with gravel to that elevation and the remaining portions, wherever muck is exposed, are to be covered with gravel to a depth of at least 6 inches.

The Department has caused the locality to be examined by its engineer and has considered the plan presented. The proposed ditches in the upper area will drain this area satisfactorily, and with a little additional ditching around the edge of the swamp it will be practicable to remove the water of the uplands without allowing any of it to flow over the surface of the swamp. The plan of filling the two lower swamps north of and adjacent to Cedar Street will greatly improve their condition, and it is likely that the filling and grading of the surface of these swamps would be a satisfactory treatment without the necessity of laying the underdrains. If it shall be found later that underdrainage is necessary, it could then be provided. There appears to be no better way than that proposed of treating the swamp south of Cedar Street and east of the ice house. Vegetation will doubtless grow up through the proposed covering to some extent and will require removal from time to time. With a greater depth of gravel there would be less likelihood of vegetation growing through the covering, but additional covering can be put on in the future if it is found necessary or desirable.

The Department, with the suggestions herein contained, approves the plan presented for the drainage of the swamps shown upon the plan submitted. The Department further finds, after an investigation, that the additional lands which it is proposed to take for carrying out this work are necessary for the proper construction and maintenance of the proposed improvement and hereby approves the taking of the parcels of land indicated on the plan submitted. The parcels, the taking of which is hereby approved, have an aggregate area of 18.4 acres and are numbered 26, 27, 28, 29, 30 and 31 and outlined in red upon the blue print filed with the application on Nov. 7, 1916, entitled "Salem and Beverly Water Supply Board Additional Supply Drainage of Cedar Street Swamp Scale One Inch = 100 Feet."

SPENCER.

Acting under authority of chapter 361 of the Acts of the year 1902, the Board of Water Commissioners of Spencer petitioned the Department to approve the temporary use of water from Moose or Whittemore Pond for the supply of the town in case of emergency. After an examination of the pond and its surroundings, the Department, on Nov. 2, 1916, replied to the petition as follows: —

At the time of this examination the pond had been drawn down several feet during the previous dry weather and the water in storage had been very materially reduced. An examination of the surroundings of the pond shows that there are several cottages along the northerly shore, most of them with privies located in the immediate neighborhood of brooks feeding the pond or the shores of the pond, which are a menace to the purity of the water. There are also other sources of pollution in the neighborhood of the pond, including a considerable number of houses on Park Street not yet connected with the public sewer, though the construction of a public sewer in this street was recommended by this Department several years ago.

Under the conditions existing at the present time Whittemore Pond cannot be regarded as a safe source from which to take water for the supply of the town, and the Department cannot recommend its use under the provisions of chapter 361 of the Acts of the year 1902.

It is probable that, if the sewage from the cottages on the northerly shore of the pond should be removed from the neighborhood of the brooks and the pond and proper receptacles for the sewage provided, much of the danger to the purity of the water of this pond would be removed, and it is possible that, after these changes are made, it would be practicable by careful inspection to prevent the pollution of the pond during the period of a few days that it would be necessary to use its waters.

In view of the fact that occasion for the use of the waters of this pond for the supply of the town has arisen frequently during the past few years, provision should be made by the town for its adequate protection by constructing a sewer to remove the sewage from the dwelling houses on Park Street and by preventing the pollution of the pond from the other buildings on its watershed.

In case it should be found necessary to use the waters of Whittemore Pond for the supply of the town before the sources of pollution are removed, it is recommended that you notify all the water takers to boil all water which is to be used for drinking.

STURBRIDGE.

On June 9, 1916, a request was received from the Board of Water Commissioners of Sturbridge for the assistance of this Department in determining a suitable source of water supply for the town. After an examination of Alum Pond and Little Alum Pond, the available sources of supply, the Department made the following reply on June 28, 1916: —

Alum Pond is located in the extreme northwesterly part of the town and has an area of about 179 acres and a watershed, including the pond, of about 0.93 of a square mile. It would supply an ample quantity of water for all of the requirements of Sturbridge at all times. The water as shown by analysis is soft and practically colorless, and it is probable that the water would be of satisfactory quality for water supply purposes, though it might, in common with the waters of many other ponds and reservoirs, have a noticeable taste and odor at times due to the presence of microscopic organisms which probably do not, however, grow in this pond in any great numbers. The pond is situated at an elevation of but little over 100 feet above the village, a height which is not sufficient to provide adequate pressure in all parts of the village if water were supplied from this pond by gravity. The chief objection to the use of this pond is the fact that there are numerous cottages situated about its shores, and the proper protection of the water from danger of pollution would involve considerable difficulty and much interference with the use of the pond by those living in its neighborhood.

Little Alum Pond is situated in the town of Brimfield about 0.7 of a mile west of the boundary line between Brimfield and Sturbridge and 2½ miles from the village of Fiskdale. This pond has an area of 48 acres and a watershed, including the pond, of about 0.78 of a square mile. The elevation of the water, judging from the State map, is approximately 170 feet above the main street in the villages of Sturbridge and Fiskdale. The pond would probably furnish an adequate quantity of water for all the requirements of the town for many years in the future, and if its elevation above the village is approximately as shown by the State map, an adequate supply could probably be obtained by gravity. The water is soft and practically colorless and of good quality for domestic use, though it is evidently affected by the presence of microscopic growths which would be likely to impart to the water at times a noticeable taste and odor. There are a few cottages about the pond which it would be desirable to purchase and remove in case the pond is used as a source of public water supply. The pond along its easterly side is shallow and contains a considerable depth of mud, and the proper location of an intake would involve considerable care. Furthermore a supply from this pond would require a long pipe line, along the route of which there appears to be considerable ledge.

Under these conditions, the cost of works for supplying water from this pond to the village of Sturbridge, including the cost of proper protection of the watershed of the pond, would be likely to be large.

In view of the circumstances, an examination has been made of the possibility of obtaining ground water from some source in the region near the village. The results of a general examination show that, judging from surface indications, the conditions for obtaining ground water in considerable quantity are favorable at several points in the valley of the Quinebaug River, especially in the neighborhood of the stream flowing from Cedar Pond into the river between the villages of Fiskdale and Sturbridge. If a sufficient supply of good ground water can be obtained in the region about the villages, the quality of the water would be much more satisfactory than that from any surface source, and the cost of the works would be likely to be less than the cost of a supply from either Alum or Little Alum Pond.

The Department recommends that you make tests by means of tubular wells in the favorable places in the valley of the Quinebaug River between the villages of Sturbridge and Fiskdale to determine the practicability of obtaining a ground-water supply in that neighborhood in sufficient quantity for the supply of the town. It is recommended that these tests be made under the direction of an engineer of experience in matters relating to water supply, and the Department will assist you by making the analyses of water and give you further advice in this matter, if you so request, when the results of tests are available.

WALTHAM.

Under date of Nov. 21, 1916, the Department sent the following reply to a communication from the city engineer of Waltham relative to the location of check valves in certain factories in Waltham operated in connection with the public water supply to prevent the entrance of Charles River water, used for fire purposes, into the water supply pipes of the city: —

From the information submitted it appears that water is delivered by the city to the works of the Boston Manufacturing Company through an 8-inch pipe which passes through the works. With this pipe there is at present connected a large steam pump having a capacity of about 1,500 gallons per minute designed to pump Charles River water into the city main and its branches in the works in case of fire. In order to prevent Charles River water entering the city mains, check valves were introduced on this main, one at each end of the works. There is no means of inspecting these check valves and they do not appear to have been examined since they were introduced many years ago. Under the circumstances, it is impracticable to determine whether or not in their present condition these check valves furnish adequate protection against the entrance of Charles River water to the city mains.

At other works in the city similar conditions are found. Ordinarily these works are supplied with water from the city main, but a fire pump is available for use in case of emergency designed to pump water from Charles River into the pipe system of the factory, and the check valves are so located that it is impracticable to determine satisfactorily whether they are working or not without shutting off the water and removing the casting containing the valve.

In the opinion of the Department, the public health is not as fully protected as it should be from the entrance of Charles River water into the water supply mains of the city, and the Department recommends that the check valves be removed as soon as practicable and all connections between the pipes likely to contain river water and the city mains discontinued. The changes required for wholly separating the two systems cannot be effected at once, however, and will probably require considerable time. The existing old check valves should, however, be removed as soon as possible and replaced by new valves, preferably duplicate check valves, which will afford more effective protection. These duplicate valves should be installed in such a way that it will be practicable to inspect them, and regular inspection should be made by the water department to ascertain with certainty whether or not they are in condition to operate properly.

Westwood.

Under date of Feb. 7, 1916, the Department sent the following reply to a request from the Westwood Town Committee for an examination of and advice concerning three tubular wells located south of the Islington station used as sources of water supply by the Westwood Water Company.

In response to your request for an examination of the sources of water supply of the Westwood Water Company, so called, and advice as to its sanitary condition and adequacy for fire protection in the village of Islington, the State Department of Health has caused the sources of supply used by the company to be examined and samples of the water to be analyzed.

The supply is taken from three tubular wells located about 20 feet west of the northerly branch of Purgatory Brook and about half a mile south of the Islington station on the New York, New Haven and Hartford Railroad. The wells are 2 inches in diameter, located about 10 feet apart, and are said to be 10 or 12 feet in depth. There are several houses in the region about the wells but none nearer than about 350 feet therefrom.

The results of analyses of samples of the water show that it is clear, colorless and odorless, and in the condition in which it was found at the time of this examination the water was of good quality for domestic use.

It is understood that there are already somewhat more than 100 water takers connected with the pipes of this system and, while the sources have yielded enough water for the requirements of the present water takers, it is not probable that the source would yield an adequate supply for the entire town without a considerable enlargement of the collecting works.

It is probable that the sources of supply can be extended in this region to yield enough water for the requirements of other thickly populated sections of Westwood without special difficulty or expense, but it will be advisable, if water is to be taken for the permanent supply of the town from this locality, that a considerable area of land in the region about the wells shall be so controlled as to prevent danger that these lands will be occupied by dwelling houses or used in such a way as to injure the quality of the water obtained from the wells in this region.

The information furnished the Department as to the size of mains indicates that they are adequate for their present use but of too small diameter to furnish a satisfactory supply of water for fire purposes. If the works are to be extended to other parts of the town and the number of water takers to be considerably increased, pipes of adequate size should be provided for the purposes for which the water is to be used. If it is to be used for the extinguishment of fires, the size of pipes required will be much greater than in case a domestic supply only is to be provided.

WINCHESTER.

Under date of Jan. 25, 1916, the Department sent the following reply to a communication from the Winchester Water and Sewer Board describing certain conditions concerning check valves between the town water pipes and the water pipes of the private system of the Beggs & Cobb Tanning Company, and requesting advice on the following questions: —

1. Whether or not the continuance of present conditions, with the single check valve and no other obstruction to the flow, is safe from the point of view of health of the inhabitants of the town of Winchester.
2. If the above is not desirable, whether or not the double check valve as proposed by the insurance company is a suitable arrangement.
3. If neither of the above is satisfactory in your opinion, can you make any suggestion as to the best method of treating this matter other than what was originally proposed by our Board, of keeping the gate valves on the private supply pipes closed and sealed except in time of fire?

The Department has caused the locality to be examined by one of its engineers and has caused tests to be made of the probable efficiency of the check valves now in use between the town water pipes and the Beggs & Cobb system. In the course of these tests an examination of one of the check valves indicates that it leaks slightly at the present time when the pressure on the town side of the valve is removed. It was also found, after opening a hydrant on the Beggs & Cobb system, that the opening became clogged by matters in the pipe so that the valve could not be re-seated. These conditions indicate the reasons why a check valve is unsafe for use in connection with the public water supply of the town. The danger is that a substance lodging beneath the valve will prevent it from closing and allow the water of the private system to enter the pipes of the town.

In the opinion of the Department, the answer to the first question contained in your application is that the continuance of your present conditions is unsafe from the point of view of the health of the inhabitants of the town of Winchester.

In answer to the second question as to whether the double check valve is a suitable arrangement, the Department is of the opinion that the double check valve reduces the danger but does not eliminate it.

In reply to your third question, the Department suggests that the best plan of providing a double fire protection in this factory would be by laying pipes from the town supply pipes in Swanton and Main streets through the factory grounds, placing hydrants in the immediate neighborhood of those now connected with the factory system. These hydrants could then be used in case the factory pressure should fall to too low a level in the course of the fire. The expense of such a system would not be great and this method would avoid the present danger of pollution of the town water supply involved in the use of check valves as at present. The Department suggests that it may be advisable also to increase the capacity of the pipe line in either Swanton or Main streets, unless these pipes have adequate feeders to provide the quantity of water which they may be required to supply in case of an extensive fire in these works.

SEWERAGE.

Agawam.

On July 11, 1916, the Department received an application from the Board of Selectmen and Board of Health of Agawam for advice relative to a proposed system of sewage disposal for the village of Agawam. The plans submitted with the application provided for constructing a sewer in Main Street between Federal and Brady streets, with an outlet easterly through Leonard Street to the Connecticut River; also for a manhole at River Road with a 20-inch iron pipe extending therefrom to a concrete abutment on the bank of the Connecticut River from which a submerged outlet of iron pipe 16 inches in diameter would be constructed into the river to a terminus about 66 feet from the bank of the stream. On Sept. 5, 1916, the Department replied to this application as follows: —

In the opinion of the Department the proposed plan of disposing of the sewage of the village of Agawam by discharging it into the Connecticut River is the best that it is practicable to adopt, and there appears to be no objection in this case to collecting both the sewage and drainage into the same pipe so as to improve the drainage of the lands along the streets in this region. It is not unlikely that at some future time a treatment of the sewage above described before its discharge into the river may become desirable, but there appears to be no objection to its discharge without treatment at the present time. The Department recommends the adoption of the plan presented.

BRIDGEWATER.

On July 25, 1916, the sewer committee of Bridgewater submitted, through their engineer, an application for the approval by this Department of a system of sewerage and sewage disposal, accompanied by a report and plans of said system. The plans provided for a system of pipe sewers in the central portion of the village to collect the sewage from certain streets and convey it to an outlet into the Town River about 500 feet north of Spring Street and 800 feet northwest of Plymouth Street, and for extending this system in the future throughout the village and disposing of the sewage eventually by means of Imhoff tanks and trickling filters, the effluent from the filters to be discharged into the river.

After a consideration of the plans and an examination of the locality, the Department gave the following advice on Sept. 11, 1916: —

It appears to the Department that the discharge of untreated sewage as proposed into the river near Spring Street from the territory which the sewers to be constructed in the beginning are designed to serve would inevitably create a nuisance in the Town River below the sewer outlet at times of low flow in the stream. Furthermore, it appears to the Department that the discharge of untreated sewage into the river is prohibited by the provisions of chapter 75, section 124, of the Revised Laws, in view of the use of the river as a source of water supply within 20 miles below the proposed outlet.

In view of the circumstances, the Department is unable to advise the adoption of the portion of the plan presented which provides for the discharge of untreated sewage into the Town River.

Regarding the plan of treating the sewage by means of Imhoff tanks and trickling filters located as indicated on the plan presented, the Department is unable to advise you definitely, since a public hearing will be necessary, as provided in chapter 49, section 1, of the Revised Laws, before final action is taken by this Department upon the proposed plans.

In view of the fact that the river is used as a source of water supply below Bridgewater, it seems to the Department important that the purification of the sewage should be as efficient as practicable and, under these conditions, the best method of purifying the sewage would be to filter it through sand or gravel filters before final disposal.

The Department recommends that you make a careful investigation to determine the best available area for the purification of the sewage by intermittent filtration and the probable cost of the works and of their maintenance. When the results of this investigation are available, the Department will advise you further as to the plans for the disposal of the sewage.

Brockton (Brockton Gas Light Company).

On Nov. 22, 1916, the Department received from the Brockton Gas Light Company an application for advice as to the quality of sand to be used in the filter for the treatment of the waste from their gas works. After examination and analysis of the sand from various parts of the banks from which it was proposed to take sand for the filter, the Department under date of Dec. 11, 1916, advised as follows: —

The samples from the northerly and southerly parts of the bank were found to be too fine for use in this proposed filter. The sample from the northwesterly corner of the bank was much coarser and of excellent quality for the purpose. There appears to be an ample quantity of this sand for the construction of the filter, and if care is exercised in taking only the coarse sand it is probable that the filter of the area now under construction will be suitable for the filtration of the effluent from the settling tanks.

It is very important for the successful operation of this filter that the settling tanks be cleaned at frequent intervals in order to secure the best results from sedimentation at all times. It is also essential that the lime apparatus be installed before the operation of the works is begun and that the necessary amount of lime, as indicated in the previous advice of this Department, be applied to the waste at all times. It is also important that, if the quantity of the waste increases beyond the amount which was being discharged at the time the investigations of the Department were made, the filters shall be enlarged sufficiently to insure that the rate of filtration shall not exceed 500,000 gallons per acre per day.

Foxborough (State Hospital).

On Oct. 23, 1916, an application was received from the superintendent of the Foxborough State Hospital for advice relative to a proposed new system of sewage disposal for that institution providing for the construction of an Imhoff tank, a small sludge-drying area, a dosing tank and two acres of sand filters to be located about a quarter of a mile northeast of the hospital. On Nov. 29, 1916, the Department replied as follows: —

The examination of the locality in which it is proposed to construct the new works shows that material can be found there which is suitable for the construction of sewage filters, and the location selected appears to be the best that is available for the purpose within the lands controlled by the institution.

In the opinion of the Department, the plan is the best practicable one to adopt under the circumstances, since it is evident that the present filters are located so close to the buildings that with the enlargement of the institution they are likely to be very objectionable, but the new filters are hardly likely to be adequate for the requirements of this institution if it is to be enlarged as proposed. The Department recommends that the area of the filter beds be increased to at least 3 acres in the beginning. The depth of the filters should be at least 4 feet, with a greater depth over the underdrains.

HULL.

On Feb. 10, 1916, the Department received a petition, signed by a number of residents on Sagamore Hill in the town of Hull, requesting the Department to take action to remove the nuisance caused by sewage overflowing abutters and into highways, and stating that the selectmen of the town had done all in their power to provide a sewer in this locality in accordance with the plans of the town engineers as approved by this Department. The Commissioner of Health brought the matter to the attention of the Board of Selectmen of Hull on March 2, 1916, in the following communication: —

> In replying to this petition I beg to say that, since the permission for the discharge of sewage temporarily into Hingham Bay has been refused by the Directors of the Port of Boston, there appear to be only two courses to pursue, one to obtain a review of the decision whereby the petition for temporary discharge into Hingham Bay was denied, and the other the construction of a main sewer to dispose of all of the sewage of Hull northeast of Point Allerton. The construction of the latter works will of course involve a considerable time, but some such plan must eventually be provided for the disposal of the sewage of the greater portion of the town.
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> In order to obtain a reconsideration of the question of a temporary discharge into Hingham Bay, probably two methods of procedure are open to the petitioners, one by appeal to the courts and the other by a petition to the Legislature. This matter was referred to in the report of this Department to the present Legislature, and this reference will be found on page 16 of House Document 431. This document is still before the Legislature for action, and if the petitioners will see the Committee on Water Supply, to whom this document is referred, they can learn whether the matter can be taken up by the Legislature and whether action can be taken by that body which will afford the relief desired. As the matter is already technically before the Legislature, there is little doubt that the Legislature could act upon the basis of the report of this Department without a new petition.

LENOX (LENOXDALE).

The Department received from the Board of Selectmen of Lenox, on May 6, 1916, an application for advice relative to the disposal of the sewage of the village of Lenoxdale, the sewage to be collected through a system of sewers aggregating a little over a mile in length into a pump well, from which the sewage would be pumped through a force main 6 inches in diameter a distance of about 1.6 miles to the present disposal works of the town of Lenox. A plan was also submitted showing a proposed settling tank and sludge beds at the disposal works for the further treatment of the sewage discharged there. On June 9, 1916, the Department replied to this application as follows: —

There is no doubt that a sewerage system is greatly needed in the village of Lenoxdale, and the plan of collecting the sewage and pumping it to the present disposal area of the town of Lenox appears to the Department an appropriate one under the circumstances. The filtration area now in use for the treatment of the sewage of Lenox is inadequate and unsatisfactory, and no material improvement has been made since the State Board of Health recommended an enlargement and improvement of this area in 1909. According to the plans presented, it is now proposed to construct a very large settling tank and sludge beds which will provide means for the effective and satisfactory preliminary treatment for all of the sewage delivered at the filtration area, including that to be pumped from Lenoxdale. The area of filter beds, however, is inadequate for the treatment of the sewage and, unless it is enlarged, it will be necessary to continue the practice of discharging the partially treated sewage into the Housatonic River as at the present time.

In the opinion of the Department, better results would be obtained by constructing a portion of the proposed tank — say one-half of it — at the present time and constructing at the same time additional areas of filter beds for the treatment of the sewage. The adequate treatment of the sewage discharged from the town of Lenox at this area will require about 5 acres of filter beds, and it is advisable that the area be enlarged to this extent at the earliest practicable time.

The Department, after consideration, recommends the adoption of the plans proposed for the sewerage of the village of Lenoxdale and recommends the construction of a settling tank and sludge beds at the filtration area, but advises that the size of the settling tank be reduced as herein suggested and that additional filter beds be constructed at the same time sufficient for the proper filtration of the sewage.

LEOMINSTER.

In response to an application from the Sewage Disposal Committee of the city of Leominster for advice as to a proposed system of sewerage for that city, accompanied by plans providing for the construction of certain trunk sewers for the collection and conveyance of the sewage to filter beds along the west side of the Nashua River, where it would be treated by intermittent filtration and the effluent discharged into the north branch of the Nashua River, the Department, under date of July 19, 1916, advised as follows: —

The area upon which it is proposed to construct the filter beds is elevated but a few feet above the normal level of the water in the North Branch of the Nashua River. Investigations show that it is practicable, by utilizing the lower lands and constructing upon them suitable filters of sand or gravel taken from the higher neighboring slopes, to provide an ample area for the disposal of the sewage of the city upon which the sewage from practically all parts of the city can readily be delivered by gravity. Numerous analyses of the material in the slopes adjacent to this low ground have shown that it is composed of deep layers of sand and gravel varying from coarse to fine and that the greater part of this material is of excellent quality for the purification of sewage by intermittent filtration. It is desirable, however, that in the construction of the filters care be taken to secure a proper mixture of this material to insure the best results in the operation of the filters.

The area provided for the disposal of the sewage in the beginning is 26.8 acres, including 11 small sludge beds. The construction of an area of this size would make adequate provision in the opinion of this Department for the present needs of the city in the matter of sewage disposal and will allow for a considerable increase in the quantity of sewage requiring disposal in the future.

The plans provide for the construction of four collecting reservoirs, having an aggregate capacity of 589,000 gallons, which will be used as dosing tanks for the distribution of the sewage upon the filters.

The filters are to be thoroughly underdrained with drains laid from 4.0 to 4.5 feet below the surface of the filters.

In the opinion of the Department the proposed system of sewage disposal will provide a practicable and satisfactory method of purifying the sewage of the city and probably the most economical and efficient method that is available at the present time.

The existing system of sewers in the city of Leominster receives both sewage and storm water and, in consequence, there is a wide variation in the quantity of sewage flowing in the sewers at different times, the quantity at times of storm being much greater than under ordinary circumstances. It would not be practicable to treat all of the sewage which flows in the sewers at times of heavy storm and it will be necessary in the beginning to allow the excess of sewage beyond the amount that may reasonably be treated on the filter beds to overflow without treatment into the stream. The Department recommends that the practice of admitting both sewage and storm water to the sewers constructed in Leominster in the future be discontinued and that the extensions to the sewer system be made wholly on the separate plan, all storm water, and ground water so far as practicable, being excluded from the sewers. It is also recommended that so far as practicable storm water be diverted from the sewers of the present system, since the storm water if unpolluted by sewage can be discharged untreated directly into local water courses without objection. It is also advisable that solid manhole covers be substituted for the perforated manhole covers now in use on a part of the sewerage system.

LOWELL.

Under date of June 12, 1916, the Department replied as follows to a request from the city engineer of Lowell for advice as to certain methods of temporary relief from the results of the present method of sewage disposal at the works of the Newton Manufacturing Company: —

It appears that the works of the Newton Manufacturing Company are located on Phœnix Avenue and that at the present time a quantity of sewage amounting to about 5,500 gallons per day is discharged from these works into a ditch leading to Trull Brook, which it enters at a point on the westerly side of Phœnix Avenue and not far from Rogers Street. The sewage causes the serious pollution of the brook at the present time and the objectionable conditions are likely to increase if the flow of the stream grows less, as is usual during the next few months. Furthermore, it is expected that the number of employees in the works may be increased considerably, which will have a further unfavorable effect upon the condition of the brook.

There appears to be no practicable way by which the sewage from these works can be disposed of into any of the existing sewers of the city of Lowell during the present season, but it is desirable that some means of temporary relief be installed until such time as a permanent and satisfactory method of disposing of the sewage can be provided. The construction of works for the treatment of this sewage in the neighborhood of the factory or in the valley of Trull Brook below it would involve a very large expense besides a very considerable delay in furnishing the required relief.

Under the circumstances, it appears to the Department that of the plans presented for securing immediate relief the more practicable is that which provides for the immediate construction of a double settling tank or catch basin similar to that suggested as scheme No. 2 in the plans submitted with your application. Each chamber of this tank would be 6 feet in diameter and the invert of the sewer entering the first chamber would be 6.5 feet above the bottom of the tank, the overflow from this chamber 6.25 feet above the bottom, while the overflow from the second chamber to the brook would be 6.0 feet above the bottom. The screen which it is proposed to install in the lower part of the overflow pipe from the first to the second chamber would best be omitted, as it might cause trouble, and the addition which is shown on the outside of the second chamber might also be omitted, allowing the overflow pipe to extend directly from the second chamber to the brook. This tank could probably be located most conveniently at Phœnix Avenue near the point where it crosses Trull Brook. If cared for properly the tank would probably remove about one-third of the organic matter from the sewage and a much larger portion of the suspended matter and, unless the flow of the brook becomes very low in the summer season, the sewage might not create objectionable conditions in the stream. In case objectionable conditions should result, it is probable that an arrangement could be made for disinfecting the sewage in the second chamber of the tank before its final discharge. In case of a material increase in the quantity of sewage, the pollution of the stream would become very serious and even disinfection might not prevent objectionable conditions occurring in the brook.

Under the circumstances, it is of the greatest importance that the city take the necessary action to provide for the permanent and satisfactory disposal of the sewage from this region at the earliest practicable time. A very considerable quantity of sewage is already discharged into the brook from a system of sewers in Wentworth Avenue and adjacent streets after passing through a so-called cinder filter. The total quantity of sewage discharged from this sewer probably amounts to about 35,000 gallons per day at the present time, and the city was advised several years ago to provide for pumping this sewage back into one of the main sewers of the city in the northerly part of Wentworth Avenue. In view of the growth of the city in this region in recent years, the best method of disposing of the sewage would probably be to extend the existing sewer, which now terminates at Draper Street near Andover Street, southerly to the neighborhood of Rogers Street, where it will intercept both the sewage of the Newton Manufacturing Company and of the Wentworth Avenue system and remove it by gravity to the Merrimack River. It does not appear to be essential that the sewer extending from Draper Street up the valley of Trull Brook shall be constructed of such large size or laid at such a depth as that portion of the sewer which has already been constructed. If the construction of sewers in this portion of the city of Lowell is continued on the separate plan, which is most desirable, a much smaller sewer laid at a comparatively shallow depth will be adequate for the effective removal of all of the sewage in this region, if the sewers are carefully laid so as to exclude storm water and ground water so far as possible. The storm water, if unpolluted by sewage, can be discharged into Trull Brook or its tributaries at the most convenient points without creating objectionable conditions.

The Department recommends the immediate construction of the double settling tank for the temporary treatment of the sewage of the Newton Manufacturing Company, and further recommends that the city begin as soon as possible the extension of a sewer up the valley of Trull Brook to intercept both the sewage of the Newton Manufacturing Company and that of the Wentworth Avenue system, and that this sewer be made of such capacity as will provide for the removal of all of the sewage of other areas within the limits of the city of Lowell in this region that will be likely to require sewerage in the future.

Mansfield (S. W. Card Manufacturing Company).

On Oct. 14, 1916, a plan was submitted, through the Bacterial Sewage Purification Company of New York, for a system of sewage disposal at the S. W. Card Manufacturing Company in Mansfield providing for the collection of the sewage in a tank having a total capacity of 8,000 gallons, and its subsequent delivery to a chlorinating tank, from which, after treatment with chlorine, the sewage would be discharged into the Rumford River without further treatment. On Dec. 5, 1916, the Department advised the company as follows: —

> The factory is located in a thickly populated portion of Mansfield and the satisfactory disposal of the sewage without a very considerable cost is impracticable except in connection with a general sewerage system for the town. The buildings are situated but little above the level of the river and the only lands available for sewage disposal do not contain soil adapted for the purpose. The best available plan of disposing of the sewage would probably be to secure some of the vacant land south of William Street and fill it with 2 to 3 feet of gravel, constructing there a sub-surface filtration area to receive the sewage discharged through a settling tank.
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> Such a system of sewage disposal would cost a considerable sum but, in the opinion of the Department, this is the best practicable method of disposing of the sewage of this factory and preventing the continued pollution of the Rumford River. A sewerage system is greatly needed in the town of Mansfield at the present time, and if the town decides to proceed with the construction of a sewerage system in the near future, it is probable that a scheme such as that proposed in the plan presented by your engineer would be one of the least objectionable methods of temporarily disposing of the sewage, but it will inevitably cause serious pollution of the river and, unless the town decides to build a system of sewerage, it is recommended by this Department that the plan of sub-surface filtration herein suggested be adopted.

On the same date the Department brought the matter of sewage disposal at the S. W. Card Manufacturing Company to the attention of the Board of Selectmen and Board of Health of Mansfield in a communication stating that the proper disposal of the sewage of this establishment was likely to be a difficult and expensive undertaking if danger of serious pollution of the Rumford River was to be prevented, and recommending the installation of a system of sewerage in the thickly populated portion of the town in order to prevent serious nuisances at those points where the proper disposal of sewage and manufacturing waste is at present impracticable.

Marlborough.

Under date of Sept. 5, 1916, the Department replied as follows to an application from the Board of Water and Sewer Commissioners of Marlborough for advice as to improving the method of treatment of the sludge at the sewage disposal works of the city as outlined in the plans and report of their engineers: —

> The plans provide for the construction of an Imhoff tank circular in plan, 40 feet in diameter and 32 feet maximum depth, to be located just south of the

existing settling tank and to be used in connection therewith. The capacity of the settling compartment of the Imhoff tank is to be about 24,000 gallons and the sludge compartment 172,000 gallons. It is proposed to continue the use of the present settling tanks by discharging the effluent of the Imhoff tank into these tanks. The sludge collecting in the present tank is to be pumped back into the Imhoff tank, and the sludge from the Imhoff tank is to be discharged upon sludge-drying beds which will replace present sludge bed No. 1. The effluent from these beds will discharge onto sludge bed No. 2, and after filtering through the latter will drain off into the regular effluent channel. It is proposed to provide a track system in order that the sludge may be conveniently handled in cars, thus preventing teaming on the surface of the beds.

The design of the tanks is based upon a tributary population of about 13,000 and a flow of sewage of about 1,000,000 gallons per day, which is about 30 per cent. greater than the flow at present.

It is proposed to so design the Imhoff tank that the settling compartment may be removed and the tank adapted to other methods of treatment, in case it should become desirable to make a change in the future.

The Department has considered the plans presented and is of the opinion that their adoption will provide the most efficient method of sedimentation that it is practicable to adopt at the present time. The odors from the present sludge beds are very noticeable in their neighborhood and are also noticeable at times on the highway passing the filtration area. It is very desirable that these odors be reduced or the sludge beds removed to a more remote part of the filtration area. The expense of moving the sludge treatment works from the present location would be considerable and, judging from the experience with the Imhoff tanks thus far constructed, the objectionable odor caused by sludge treatment is likely to be reduced if the plan now proposed is carried out.

Under the circumstances, the Department recommends the adoption of the proposed plan as a part of the sewage disposal system of the city of Marlborough.

Medfield (State Hospital).

Under date of Feb. 15, 1916, the Department sent the following communication to the State Board of Insanity in response to their application for advice as to the improvement of the sewage treatment works of the Medfield State Hospital: —

It appears that the population of the institution at the present time is approximately 2,125 and, while no measurement is made of the quantity of water used, such observations as have been made by your engineers and by the engineers of this Department indicate that the quantity of sewage discharged from the institution at the present time may exceed considerably 300,000 gallons per day. The sewage is at present discharged in part to a small settling tank constructed not far from the institution buildings, the overflow from which, together with sewage from other buildings which are not connected with the settling tank, is discharged to filter beds in the valley of Charles River, the effluent from which finds its way to the river. There are at the present time nine filter beds, having an aggregate area of 2.7 acres, and two sludge pits, into which sludge is discharged from the settling tank. The rate of filtration on these filters, if all the sewage were filtered, would be approximately 120,000 gallons per acre per day, and it is obvious that the filters are inadequate for the disposal of all of the sewage now discharged upon them. Considerable quantities of sewage have evidently been allowed to overflow at times into Charles River, a stream which is used extensively as a source of water supply and is showing at the present time marked evidences of increasing pollution.

Under the circumstances, in the opinion of the Department, it is essential for the proper protection of the water supplies in the valley of the Charles River that adequate filters shall be provided for the treatment of all of the sewage of the Medfield State Hospital at the earliest practicable time.

The plan now proposed provides for the abandonment of the present settling tank, which is poorly located and entirely inadequate for the purpose, and the construction of an Imhoff tank, so called, with preliminary screening of the sewage and a sludge bed for the disposal of the sludge. From the Imhoff tank the sewage will be discharged into a dosing tank and thence to the filters, the area of which is to be enlarged by the construction of two additional filter beds, making the total aggregate area 3.3 acres, or about 0.2 of an acre less than recommended by this Department in 1908.

The Department has considered the application and the plans presented therewith and is of the opinion that these works, if carried out as designed under competent engineering supervision, would probably be capable of purifying adequately all of the sewage at present discharged from the institution to such a degree that it will be permissible to discharge the effluent directly into the river. The operation of such works, however, will require considerable care in order to secure the best results and, judging from experience in the disposal of sewage under similar circumstances, there would be greater certainty of satisfactory results if the full area of 2.3 acres of filters suggested in the report of the engineers should be constructed in the beginning and the construction of the settling and dosing tanks postponed until the efficiency of the operation of the works without these accessories can be determined.

If the full area of filters suggested is constructed in the beginning and the construction of the settling and dosing tanks postponed, the cost of the works would be about the same as the cost of the smaller area of filters with the proposed settling and dosing tanks.

The Department recommends that the full additional area of filters, viz., 2.3 acres, be constructed at once and the construction of settling and dosing tanks postponed until the efficiency of the works has been more accurately determined.

The Department recommends that the further use of the present settling tank and sludge pits be discontinued as recommended by your engineers and that the remaining portion of the works, including the screens and existing filters, be repaired where necessary and placed in condition for the most efficient operation.

MEDFORD.

On June 23, 1916, the Department received from the city engineer of Medford a request for its approval of the construction of an overflow from the sewer in the Mystic Valley Parkway to the Mystic River, accompanied by a letter from the Metropolitan Water and Sewerage Board to the city engineer relative to the conditions affecting the discharge of sewage from the area in question into the metropolitan system. The following reply was sent on July 19, 1916: —

From this letter it appears that it has been necessary in the past, and may be necessary at times in the future, to discharge sewage from the metropolitan sewers into tidal waters during a period of accident to the system or other emergency and that it is desirable that these overflows should discharge at points where outlets are already provided. If the sewer in question in Medford were connected to the metropolitan sewer and constructed at the low level required by the street surface, the sewage would probably at times back up in the sewer and create objectionable conditions either by overflow from the manholes in the street or from other causes. Under the circumstances, the connection of this sewer with the metropolitan sewer would be objectionable, unless provision were made for shutting off the sewer from the metropolitan system at times of emergency, thus necessitating an overflow from the local sewer.

The State Department of Health has carefully considered the question of an overflow into the Mystic River for the sewage of the low districts in the neighborhood of the Mystic Valley Parkway and is of the opinion that, in view of the size and character of this stream and its present uses, the discharge of sewage into the river would be very objectionable and probably injurious to health. The Department is, therefore, unable to advise the construction of such an overflow.

It appears to be possible to prevent the entrance of sewage into the Mystic River in this locality by conveying the sewage of the low areas to a common point and installing there a low-lift pump which will discharge the sewage into the metropolitan sewer at such elevation that there will be no danger that the backing up of sewage in the latter sewer will cause an overflow through the manholes along the parkway or elsewhere.

It might also be possible to lay a gravity sewer under the sidewalk of the parkway so as to enter the metropolitan sewer at such an elevation that the backing up of the sewage would not cause it to overflow through the manholes in the parkway, but this can only be done by raising the grade of the sidewalk in this portion of the parkway to which there might be serious objection.

It seems desirable, in the opinion of the Department, that the city of Medford shall establish minimum grades below which no street or cellar shall be constructed, these grades to be established after careful consideration of the conditions affecting the disposal of sewage and drainage from the various low-lying areas in the city.

MILFORD.

In consequence of a complaint by certain petitioners alleging a nuisance caused by the discharge of sewage upon the ground in the neighborhood of Depot and Vernon streets in Milford, the Department caused the locality to be examined, and under date of Aug. 23, 1916, sent the following communication to the Board of Health, the Board of Selectmen and the Board of Sewer Commissioners of Milford: —

It appears from the examination that a large pool of sewage has collected on the land lying between Depot and Vernon streets and the railroad which has evidently been discharged from the main sewer of the town of Milford. An offensive odor from this deposit was plainly noticed in the neighborhood, and numerous small flies were observed in the vicinity of the sewage deposits. In the opinion of the Department, the conditions constitute a most serious nuisance.

This matter was brought to the attention of the town authorities by this Department in a communication dated August 5, 1914, a copy of which is appended hereto. It appears that following this communication the sewerage commissioners of the town in their report to the town in 1914 made the following recommendation:

> . . . The most important matter demanding consideration in the line of further construction is the necessity of laying an additional siphon in Depot Street. By reference to page 20 of the original report of the engineer, it will be seen that, in order to obtain a self-cleansing velocity during the early years of the system, the capacity of the siphon originally laid was intentionally made materially less than that of the main sewer, and it was estimated that another pipe would have to be laid about 1920. Owing, however, to the leakage into the sewers, it has become necessary to lay an additional pipe immediately, in order that the flow during the spring months may be carried off without backflooding of the main sewer and overflowing from the manholes into the street.
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> The engineer has estimated this siphon to cost $8,200, and allowing for contingencies, it is recommended that authority be obtained from the Legislature to issue additional bonds to the extent of $10,000 for the purpose of laying a 16-inch cast iron siphon in Depot Street.

No appropriation for the purpose appears to have been made at that time, and the matter was again brought to the attention of the town by the sewer commissioners in their report for 1915 in the following statement:

> We believe it to be our duty again to call your attention to the necessity of laying an additional siphon in Depot Street, to which reference was made in our last report. The number of connected premises is increasing yearly, and experience has already proved that, because of leakage into the sewers, the present siphon has not sufficient capacity to carry off the flow during the spring months of a wet year. Unless, therefore, an additional pipe is laid, the town must recognize the fact that if a wet year should occur, sewage will overflow from manholes in Depot street and damage will result. We therefore recommend that authority be obtained to issue additional bonds to the extent of $10,000 for the laying of a 16-inch cast iron siphon in Depot street.

The existing conditions are, in the opinion of the Department, a great menace to the health of the town and should no longer be allowed to exist. The Department recommends that the construction of a new siphon be undertaken without further delay and that in the meantime the pool of sewage be thoroughly disinfected after each discharge and the contents removed in suitable carts as soon as possible after discharge. The material should be disposed of at some suitable place containing porous soil and should be immediately covered with earth.

NATICK.

In response to the request of the superintendent of the Sewer Department of Natick for advice relative to the condition of the sewage filter beds of the town, the Department caused the filter beds to be examined, and, after a consideration of the results of analyses and the records of operation of the filters, made the following reply on Dec. 30, 1916: —

In the earlier years the quality of the effluent was satisfactory, but deterioration began in the year 1904 and increased decidedly until the year 1908, when a change was made in the method of operating the filters and a great improvement resulted therefrom. The effect of this improvement continued for several years, but later on in 1912 and 1913 deterioration again set in, the quantity of iron and organic matter in the effluent increased, accompanied by a decrease in nitrates, and these changes have recently become more rapid, especially during the past year. The deterioration in the purification effected by these filters appears to be due largely to the excessive quantity of sewage now applied to them and to the unsatisfactory condition of the lateral underdrains, most of which are probably clogged. The rate of flow of sewage to the filter beds during the year 1916 was such that the average quantity applied amounted to about 80,000 gallons per acre per day. The quantity varied greatly, however, being very much smaller in the drier part of the year and very great in the winter and spring when the flow was increased by the leakage of ground water into the sewers. While this leakage may be of some advantage in lowering the level of the ground water in the town and preventing wet cellars and other objectionable conditions, the quantity allowed to leak into the sewers is undoubtedly excessive and could probably be greatly reduced without affecting materially the desirable lowering of the level of the ground water, as was recommended in a communication from this Department in 1911.

The town has grown quite rapidly during the past few years and there has been a considerable increase in the quantity of sewage discharged at the works. Under the circumstances, unless leakage into the sewers can be materially reduced, there is no doubt that an increase should be made at once in the area of the filter beds. The area now in use is 12.6 acres, which is only 1.5 acres more than that used in 1903, while on the other hand the number of connections with the sewers since 1903 has more than doubled and the quantity of sewage requiring disposal has increased as much as 75 per cent.

The present filter beds cannot receive and purify satisfactorily the quantity of sewage now discharged upon them and, unless a very material reduction can be made in the quantity of leakage entering the sewers, additional filters will have to be provided. In order to bring the present filters into satisfactory operation, it will be necessary to provide adequate underdrainage, either by digging up and relaying the present lateral underdrains, as was done with the main underdrains in 1908 and 1910, or by providing new drains laid between the present drains. With the improved underdrainage system, there should also be inaugurated a method of operating the filters which will provide for the use of each filter each day when the flow is large, except when a bed may be out of use for cleaning or repairs. In dry periods when the quantity of sewage is small the filters should still be used in rotation so far as practicable and the sewage applied as uniformly as practicable, though the quantity applied to each may be comparatively small.

The Department recommends that the improvement of the present filters be taken up promptly next spring and the lateral underdrains relaid in all of the filters, so far as may be found necessary. The Department also recommends that at the same time the question of preventing leakage be given careful consideration, and if it is not found to be practicable to reduce materially the discharge of sewage to the filters by decreasing the leakage, that additional filters be provided sufficient in area to make it practicable to dispose of all of the sewage satisfactorily at all times.

Northampton (Hampshire County Sanatorium).

Under date of Jan. 25, 1916, the Department sent the following communication to the Hampshire County Commissioners in reply to their request for advice as to the enlargement and improvement of the filter beds at the Hampshire County Sanatorium: —

It appears that the quantity of sewage now discharged from the sanatorium amounts to about 3,500 gallons per day. The sewage is collected in a tank having a capacity of about 6,000 gallons, and subsequently discharged upon a filter bed having an area of 1,200 square feet, or .028 of an acre. This filter, while it appears to have disposed of all of the sewage discharged upon it up to the time of the examination, has apparently become clogged and an enlargement of the works is necessary.

The plan submitted by your engineer provides for constructing an additional filter having an area of 1,400 square feet or about .032 of an acre and for reconstructing the underdrains in the present filter which appear to have become inoperative. With the new filter and the present filter in satisfactory operation, the rate of filtration of the sewage of this institution with the present population would be about 50,000 gallons per acre per day.

In the opinion of the Department, by constructing the proposed new filter and reconstructing the underdrains in the present filter so as to bring it into satisfactory operation, it will be practicable to purify effectively the sewage at present discharged from the sanatorium. It is necessary, however, in order to secure satisfactory purification of the sewage to reduce the size of the settling tank in which the sewage is now stored, since by storage for more than a day the sewage becomes putrid and offensive and difficult to purify. By dividing the tank into three portions, one portion could be used while another is being cleaned, and it is also desirable to provide a flush tank, which would be an advantage in dosing the filters.

The Department recommends that the tank be subdivided and a dosing tank provided in connection with the construction of the proposed new filter. It has been proposed that the underdrains be placed at a level 3 feet below the surface, but, in view of the character of the sewage, the Department recommends that the underdrains be laid 5 feet beneath the surface as in the filter already constructed. It is important that these changes be made at the earliest practicable time in order that a sufficient area of filter beds shall be available to purify all of the sewage of the institution at all times, and in case the number of patients and attendants at this hospital is likely to increase in the future, the area of the filters should be made correspondingly larger.

Regarding the use of the sludge for fertilizer, the Department is of the opinion that it is important, as in all cases where sewage sludge is used for that purpose, that it shall not be employed upon any lands on which fruits or vegetables eaten raw are likely to be raised.

READING.

On Oct. 9, 1916, an application was received from the Board of Sewer Commissioners of Reading for approval by this Department, under the provisions of chapter 314 of the Acts of the year 1909, of a plan for a system of sewerage for the town. After a hearing on October 17, at which a detailed plan of the proposed system of sewers was submitted for the consideration of the Department, the following communication was sent to the Board of Sewer Commissioners on October 21, 1916: —

The plan provides for collecting the sewage of practically all of that part of the town of Reading which lies within the watershed of the Saugus River into a system of pipe sewers, through which it will be discharged by gravity into a branch of the north metropolitan sewer at Brook Street at the extreme southern boundary of the town. The extreme easterly part of this district is at present very sparsely settled, and it may possibly be found more economical and desirable in the beginning of its development, and while the population is small, to dispose of the sewage temporarily by pumping it to one of the main sewers in the adjacent section of the town, thus postponing for a time the construction of the gravity sewer designed to serve this area. This possibility is provided for in the plan presented, and a location is indicated for a temporary pumping station near Salem Street, between Winter Street and Libby Avenue, to raise the sewage of this territory into the main sewer in Salem Street near Winter Street, in case this method of disposal should be found desirable for a time. Considering the circumstances, the question of the best method of discharging the sewage of this, at present, sparsely settled area into the main system can be left for determination as occasion may arise.

The plan provides further for collecting the sewage of that portion of the town within the watershed of the Mystic River, including a portion of the territory draining toward the Ipswich River, at a pumping station near Willow Street about 300 feet southwest of the point where that street crosses the Boston and Maine Railroad and for pumping the sewage from this point through a force main to a main sewer at the corner of Hancock and Woodbine streets, through which it will flow to the metropolitan sewer.

The Department after consideration voted to approve the plan of the system of sewerage presented, said plan being entitled "Reading Sewerage System. Plan showing Lateral and Intercepting Sewers. Scale 1 inch = 500 feet. Sewer Commissioners, C. R. Herrick, H. A. Bancroft, John W. Owen. F. A. Barbour, Engineer. September 1916."

RUSSELL.

Under date of Oct. 21, 1916, the Department gave the following advice to Mr. E. D. Parks relative to sewerage for certain houses located on Main Street, in Russell: —

The plan provides for collecting the sewage from the houses indicated in an ordinary pipe sewer and discharging it into Bradley or Black Brook at a point about 400 feet east of the State road and about 900 feet from the Westfield River. The water in the brook at the proposed point of discharge is quite shallow, but farther down stream there is a considerable pool which, the Department is informed, is used to some extent as a place for bathing. There is also a number of dwelling houses at no great distance from the brook below the point of discharge.

Under these conditions, the Department is of the opinion that the discharge of sewage at the point proposed might create objectionable conditions and cause injury to health.

It is possible that the quantity of sewage discharged from the houses in question could be properly disposed of by means of a tank and sub-surface filtration bed in the neighborhood of the proposed outlet. It would be much better, however, to lay a sewer in the beginning to a suitable outlet in the Westfield River, as recommended by this Department to the authorities of the town in a communication dated June 9, 1913, a copy of which is appended hereto.

Until a town sewer is available, the best practicable plan of disposing of the sewage of the houses in question would probably be by the use of a sub-surface filter constructed near the proposed sewer outlet, which would provide temporarily for the disposal of the sewage until the construction of the town system.

On the same date the following communication was sent to the Board of Selectmen of Russell relative to the above matter: —

A copy of the advice of the State Department of Health to Mr. E. D. Parks of Russell relative to the disposal of the sewage of certain tenement houses in that village is appended hereto for your information.

It is very important, in the opinion of the Department, for the protection of the public health, to prevent the pollution of the streams in this village, and a plan has already been recommended by the Department to the authorities of the town, under date of June 9, 1913. It is very difficult to dispose satisfactorily of the sewage of the dwelling houses in question and probably also of others in the village, even by temporary means, under present conditions without danger of polluting seriously local water courses and creating other objectionable conditions.

The Department recommends that the question of sewerage be taken up by the town again at the earliest practicable time and that provision be made for the collection and proper disposal of all of the sewage of the thickly settled portion of the village.

TAUNTON.

In response to a petition from the selectmen of the town of Dighton requesting action by the State Department of Health to remedy the objectionable conditions in the Taunton River caused by the discharge of sewage from the city of Taunton, the Department gave a hearing to the parties interested at the City Hall in Taunton on Dec. 6, 1916, and on December 12 sent the following communication to the Board of Sewer Commissioners of the city of Taunton: —

In response to a petition from the Selectmen of the Town of Dighton representing that the City of Taunton is discharging sewage into the Taunton River, notwithstanding the order of the State Board of Health made in 1910 to otherwise provide for its disposal, and also protesting against further pollution of the river and requesting immediate action to remedy the existing conditions, the State Department of Health gave a hearing to the Town of Dighton and the City of Taunton, and other parties interested, at the City Hall in Taunton on December 6, 1916.

After this hearing and after consideration of the records of the State Board of Health, the Department finds that the order of the State Board of Health dated September 7, 1910, has not been complied with by the City of Taunton. It appearing, however, that the authorities of the City of Taunton are willing to proceed with the preparation of plans for an efficient system of disposal for the sewage of the city and to present them to the State Department of Health for its approval within three months from the date of the hearing and that, further, the authorities of the City of Taunton propose to petition the Legislature of 1917 for authority to incur indebtedness to an amount which will be sufficient to enable the city to construct a satisfactory system of sewage disposal, this Department voted to continue the matter until March 6, 1917.

In the opinion of the Department, the sum of $75,000, mentioned at the hearing, would be quite inadequate for the construction of an efficient system of works for the disposal of the sewage of the City of Taunton. The Department recommends that an estimate be prepared at once of the probable cost of the construction of such works under the advice of an engineer of experience in matters relating to sewage disposal and that this estimate be used as the basis of the proposed petition to the Legislature for authority to increase the borrowing capacity of the city for sewerage purposes.

WARE.

On July 22, 1916, an application was received from the Board of Selectmen of Ware, through the town counsel, for advice relative to a proposed sewerage system for a small district comprising between 25 and 30 acres adjacent to the Ware River, the general elevation of which is such that sewage cannot be discharged into any of the existing sewers in the neighborhood without pumping. The plan submitted with the application provided for a new outlet about 1,100 feet down stream from the more southerly of the two main outlets at which sewage is now discharged into the Ware River. On Sept. 5, 1916, the Department replied to this application as follows: —

> The examinations of the Ware River made by this Department show that the stream is very badly polluted by the sewage and manufacturing wastes which it already receives and, in the opinion of the Department, a serious nuisance is likely to occur in the neighborhood of the lands which it is now proposed to develop for building if the town continues to grow and the pollution of the stream is allowed to continue. Under the circumstances, it is important that provision be made as soon as practicable for the removal of the sewage from the present sewer outlets to some point farther down the river or for its treatment for the removal of organic matters therefrom before it enters the river.
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> In view of the conditions, the outlet now proposed must be considered as a temporary one, and it is recommended that it be carried well out into the stream so as to prevent the sewage from returning and fouling the shores.
>
> In view of the probable necessity of improvement in the present methods of sewage disposal of the town, it is advisable that the sewers in the area in which it is now proposed to provide sewerage shall be constructed strictly on the separate plan and all storm water and ground drainage excluded therefrom. If this plan is followed, the expense of treating the sewage or removing it to a new outlet will be greatly reduced.

WESTFIELD.

On May 12, 1916, the Department received from the town engineer of Westfield an application for advice relative to a proposed sewer outlet for the disposal of the sewage of a portion of the town, accompanied by a plan showing sewers in certain streets with a temporary outlet into the Westfield River, and providing for the diversion of the sewage from the temporary outlet to the main sewer outlet of the town when necessary. On June 9, 1916, the Department advised as follows: —

The Department has caused the locality to be examined by one of its engineers and, having examined the proposed plan, finds that the discharge of the sewage temporarily from the area indicated into the Westfield River opposite Miller Street is permissible under present conditions, provided that the outlet is located at a sufficient distance from the bank to prevent sewage from returning thereon and creating objectionable conditions in the neighborhood. If the outlet is located at least 30 feet from the bank of the river at a point where it will be covered with water at all times, it is unlikely that this outlet will become objectionable until the population near the river farther down stream becomes greater than at the present time.

Winchester (Beggs & Cobb Tanning Company).

Under date of March 13, 1916, the Department sent the following communication to the Beggs & Cobb Tanning Company in Winchester in response to a request from their attorney for advice as to the disposal of sludge collected in the settling basins through which the wastes from the tannery are discharged into the metropolitan sewers: —

It appears that the sludge when removed from the settling basins gives off an odor which has been a source of complaint to the Health Board of Winchester, and a change in the method of disposing of the sludge is desired. It is probable that the discharge of the wastes into the metropolitan sewerage system without sedimentation would be objected to on the ground of the danger that these wastes would create deposits therein, and it will probably be necessary to dispose of them by some other plan. It does not appear that the suggestion of this Department on July 10, 1912, that the sludge be deposited on sludge beds composed of sand, cinders or sawdust, well underdrained, has yet been tried because of the fear that the odor given off by the sludge while drying would be objectionable. It is, nevertheless, probable that the sludge could be deposited on such beds and if promptly covered with suitable material, such as earth or ashes, and subsequently removed after drying for a few hours the objectionable odors would be avoided. The sludge deposited upon such beds dries quickly and when dried the objectionable odor disappears.

This Department has experimented extensively with methods of disposing of sludge of various kinds, and the results of these experiments have been published in its reports from time to time. These results show that sludge of certain kinds can be disposed of without odor when stored in deep tanks and allowed to remain for a considerable time. The experiments have included tests for the disposal of tannery sludge, the results of which show that, by depositing this sludge in a tank 17 feet in depth and drawing it out after one month's storage therein, the material is odorless.

Whether it is feasible to dispose of all of the sludge of your tannery by this plan, the Department is unable to advise you at the present time, but it is recommended that an experiment be made by constructing a tank for the purpose in order to test the efficiency and probable cost of this method of disposal. The Department will assist you in such an investigation by advising as to plans for the construction and operation of such a tank and will give you further advice in the matter when the results of tests of this method of disposal of your wastes are available.

MISCELLANEOUS.

HOLLISTON.

On Aug. 29, 1916, the Department sent the following communication to the Board of Health of Holliston in response to their application for advice as to the drainage of a certain section of the town along the Winthrop Canal: —

Winthrop Canal is the outlet of Winthrop Lake and flows with a very slight fall through the central part of the village of Holliston, — the total fall, according to the information furnished to the Department, being only 2½ feet between Winthrop Lake and Linden Lake, a distance of nearly a mile.

There are numerous houses along the streets which border the brook, in the cellars of which standing water accumulates at times of heavy rain and when the water in the brook is high. This condition is very objectionable and no doubt injurious to health. The stream also receives considerable pollution from sink drainage and other refuse, considerable quantities of which, in the absence of a sewerage system, find their way into the stream.

The present conditions along the valley of this brook are very objectionable and would doubtless become worse if the dam in Linden Lake were again maintained at its former height. The best method of removing the objectionable conditions in this valley will undoubtedly be to deepen and enlarge the channel of the stream from the neighborhood of Linden Lake to Winthrop Lake; and in connection with such a scheme it is very desirable that the town secure control of the dam at Linden Lake. This dam is now broken away and the water power has not been used for many years, so that it is probable that the town can obtain the flowage rights at the present time at a reasonable cost.

In order to determine definitely the location, size and depth of channel necessary for this purpose, surveys and soundings should be made along the line of the brook and plans and estimates of cost prepared. This work should be carried out under the direction of an engineer of experience in the construction of such works, and when the plans are prepared this Department will be pleased to advise you concerning them if you so request.

Newton and Watertown.

On Aug. 16, 1916, the Department received a communication from the Metropolitan Park Commission relative to certain sources of pollution of the Charles River, and requesting action by the Department relative thereto. Under date of Dec. 12, 1916, the Department replied to this communication as follows: —

The Department finds that a limited amount of waste enters the river in the locality indicated, none of which appears to be of the nature of sewage or manufacturing waste, with the possible exception of a sink drain from the property of L. C. Chase and Company just below the Watertown dam. The river receives, however, in this region considerable wash water of various kinds, some of which evidently contains a considerable quantity of oil.

At the Lewando French Dyeing and Cleansing Company the yard drainage and floor drainage from the garage discharge into the river through a drain pipe, and the drainage of the floor system for the large new garage under construction is to be connected with this pipe. When auto trucks are being washed in the garage, large quantities of water containing considerable oil are discharged into the river. Oil dripping from the automobiles in the garage and in the yard also finds its way to the stream.

Just below the Galen Street bridge accumulations of oily machine waste were found at several points along the banks of the river, having been evidently thrown from the windows of the car barn. Considerable oil from this waste probably finds its way to the river at times of rain.

The wastes from the Warren Soap Manufacturing Company at the time of the examination were being discharged into the sewer, but down stream from this factory there is a yard in which barrels used for the transportation of tallow, grease and soap are stored, and the ground at this location shows the presence of considerable grease, some of which is doubtless washed into the river at times of rain.

At the works of the Newton and Watertown Gas Company no gas is now being made, but the boiler room on this property furnishes steam to neighboring works. A pipe for the purpose of carrying exhaust steam from blowing off the boilers and the return drip from the steam mains discharges into the river at this place and the water has a yellow color, due perhaps to iron and in part to compounds used to prevent the formation of scale in the boilers. This waste does not appear to contain any oil. At times of rain a small amount of water probably overflows from the water seals on the gas holders, but no overflow had taken place during the examination.

At the Stanley Motor Carriage Company's works a separator is in use for separating oil from wash water from the floors in the garage where automobiles are washed, but the surface drainage from the street and the yard drainage from the company's property discharge directly to the river, and as both street and yard are saturated with oil no doubt considerable oil enters the stream at times.

While the pollution of the river in the manner above described does not appear to be injurious to health and the existing conditions probably do not tend seriously to create a public nuisance or to obstruct the flow of water, they nevertheless produce unsightly and objectionable conditions in the stream in the neighborhood of the points of discharge and should be prevented.

Since most of the pollution is caused by oil and oily water entering the stream, chiefly at the Lewando dyehouse, the car barn, the works of the Warren Soap Company, the gas works, and the Stanley Motor Carriage Company's works, the best plan of removing the objectionable conditions now complained of would be to secure the introduction of oil separators on all waste pipes discharging from garages and other places where automobiles stand and from yards and areas saturated with oil and grease and to provide for the proper care of these separators at all times. A separator is already in use at the works of the Stanley Motor Carriage Company but is not adequate for the best efficiency at the present time. The throwing of all oily waste upon the ground about the car barn can no doubt be prevented without difficulty.

While it may not be practicable to prevent wholly the entrance of oil and grease from the various works into the river because a considerable portion of it will doubtless continue to find its way through the ground to the river, it will nevertheless be possible, by the introduction of separators on all pipes connecting with the river, to reduce very greatly the present objectionable conditions.

The Department will be pleased to assist your department, so far as it can, in securing the improvement of the condition of the water of the Charles River in this region.

STOUGHTON.

On Aug. 3, 1916, the Department sent the following communication to Messrs. French & Ward, Stoughton, in response to their request for advice relative to treating the waste from their factory for the purpose of preventing the entrance of objectionable matter into the Neponset River: —

It appears from the investigations of this Department that when your disposal works were first constructed the quantity of waste requiring treatment was from 30,000 to 40,000 gallons per day. Subsequently in 1911 measurements showed that the total quantity of waste from your mill amounted to about 80,000 gallons per day, of which 50,000 required treatment, and you were advised to enlarge your purification works. This enlargement was made by increasing the area of the filters. Recently there has been a further large increase in the amount of waste discharged from your factory, and measurements made during the past few weeks indicate that the total quantity of waste flowing from your mill in a ten-hour day amounts to about 250,000 gallons.

The area of filters now used for treating these wastes amounts to about one acre. An examination of these filters shows that the upper layers are now badly clogged with fatty matters, and in order to keep the filters in proper working operation it is necessary that about 2 inches in depth of material be removed from the surface of these filters and replaced with clean sand. With this improvement the filters would doubtless be capable of caring for the quantity of waste which they were designed to receive, but they are inadequate for the effective treatment of the large quantity of waste now discharged from your mill.

A study of these wastes indicates that a considerable portion of them consists of comparatively clean water used in rinsing cloth, and there would appear to be no objection to discharging the last one-third of the wash water into the river without treatment. In order, however, to avoid the discharge of objectionable matter into the stream it will be essential that much care be exercised, both in arranging the outlets of the machines so as to divert the rinse water into the river, and in seeing to it that the rinse water is not diverted to the stream until the rinsing is about two-thirds completed.

The quantity of waste remaining which now requires treatment amounts at the present time to about 190,000 gallons per day. Experiments upon the treatment of these wastes indicate that they can be effectually precipitated in a properly designed tank by the use of alum varying in quantity from 2,500 to 7,000 pounds per million gallons of waste, the quantity varying according to the strength of the waste. Experiments with lime in place of the alum were also carried out but with less satisfactory results; in fact, with 10,000 pounds of lime per million gallons and a long period of sedimentation, the results were much less satisfactory than with 5,000 pounds of alum per million gallons and a short period of sedimentation. Under the average conditions a quantity of alum amounting to 3,500 pounds per million gallons will be sufficient for the purpose, and this rate of treatment will require a quantity of alum amounting to from 650 to 700 pounds per day. With this treatment and a period of sedimentation of from two to four hours, the resulting waste should be very effectually purified, and by discharging it upon the present filters the objectionable properties can be removed from the wastes and the effluent of the filters discharged into the river without objection. It is of especial importance that the treatment works be designed, constructed and operated under the supervision of an engineer of experience in the treatment of such wastes. The recommendations of the Department are summarized as follows: —

1. That the various washing machines be provided with two way valves, by which the first or dirty portion of the wash and rinse may be collected together with the other wastes and the last third at least of the rinse discharged into the stream.

2. That an apparatus be installed at the collecting well by which a certain measured quantity of alum may be introduced to the wastes at the intake of the pump and that a quantity of alum — to vary according to the strength of the waste — between 2,500 and 7,000 pounds per million gallons, with an average amount of about 3,500 pounds per million gallons, be applied to the wastes.

3. That the wastes be conveyed thence to a settling tank of 40,000 to 50,000 gallons' capacity.

4. That three sludge beds with an aggregate area of about .3 of an acre be provided.

5. That $1\frac{1}{2}$ or 2 inches of material be removed from the existing filters and that it be replaced with sand of good quality for the purpose.

6. That the filters be used for the filtration of the precipitated wastes during the dry warm months.

7. That the works be designed, constructed and operated under the supervision of an engineer of experience in such matters.

WALPOLE.

On April 12, 1916, the Department sent the following communication to Messrs. Bird & Son, East Walpole, in response to their application for advice relative to treating certain wastes from their mill: —

The proposed method of treatment is set forth in your application as follows: —

Proposed Plan of Treatment. Realizing the failure of the sand filters to meet our expectations and to satisfactorily deal with these wastes, we have made further investigations which have resulted in the tentative adoption of the following plan of treatment for the future: —

The wastes from the washing engines will be conducted by gravity to a new equalizing and settling tank having a capacity of not less than 60,000 gallons. The wastes will be introduced into this tank at a point considerably below the center of the tank. They will flow continuously through this tank, depositing in it a large proportion of the suspended matter, and will become mixed in such a way that the effluent will have a fairly uniform quality. From this tank the wastes will flow into a smaller reservoir from which they will flow to a pump well, into which will also be discharged the pink machine and other wastes. Before reaching the pump they will receive a measured quantity of sulphate of alumina solution. They will then be pumped through a force main to the present settling tanks at the filter beds. Four new tanks similar to those now in use will be provided, with necessary accessories. The equipment of the old tanks will be so modified and that of the new tanks will be such as to provide for operation by the fill and draw method. The space between the two lines of tanks will be housed so as to provide for efficient operation of this part of the plant.

Extensive tests of this method of treatment indicate that it will be possible to produce an effluent by this method which will be stable, practically clear, substantially free from suspended matter and without material color except when pink machine wastes are being received, when it will have a slight pink color.

An equally good result can be obtained by using a smaller quantity of chemicals and passing the effluent from the tanks through the present sand filter beds, which experiments indicate can handle this effluent at the rate of at least 250,000 gallons per acre, per day during the warm season. It will be necessary, however, to increase the area of sludge beds and it is proposed to utilize present filter beds 1–5 inclusive, for this purpose. The area of the remaining filters, 6–9 inclusive, having an aggregate of 1.38 acres, will, therefore, be available for the filtration of tank effluent.

Unless you disapprove we shall proceed with the work necessary to put this plant into operation. Before closing we might add that we realize that the yearly cost of chemicals to treat this waste will be enormous, but it is the only method, in our opinion, which will prove to be satisfactory.

The results of the investigations and experiments upon which the foregoing plan is based have been made available to this Department by your engineers, and from this information it appears that the less expensive plan would be thorough chemical precipitation of the wastes discharged from your mill during the winter and partial chemical precipitation, with subsequent filtration through the present sand filters, during the remainder of the year.

In addition to the experiments made by your engineers, the Department has caused the wastes to be examined and has caused experiments upon the treatment of these wastes to be made at the Lawrence Experiment Station, both by chemical precipitation and filtration, and has considered the results of numerous experiments upon the treatment of wastes from this mill in past years.

The quantity of wastes from the washing machines and that from washing the floors, machines, etc., appears to average from 300,000 to 350,000 gallons per day, while the pink machine wastes, which are present about 25 per cent. of the time, bring the average up to from 500,000 to 600,000 gallons per day.

The results of these experiments and of experience in the operation of your present works show that the best practicable purification of these wastes cannot be effected by filtration alone. Furthermore, it appears to be difficult to operate the sand filters in the winter season with wastes of such character as those now discharged from your works.

The experiments indicate that, by sedimentation for a period of two to four hours followed by treatment with alum, using about 7,500 pounds per million gallons, and a further period of sedimentation of about four hours, the effluent can be applied to the existing sand filters at the rate of about 250,000 gallons per acre per day and a final effluent obtained which will be considerably better in quality than that which has thus far been produced by the existing filters. The experiments also indicate that, if the quantity of alum is increased to about 10,000 pounds per million gallons, as proposed, during the three coldest months, a fair effluent may be produced.

Judging from the results of these experiments, the Department is of the opinion that the proposed treatment of your washer wastes, including the pink paper machine wastes and other waste waters resulting from the washing of machinery, etc., will relieve materially the objectionable conditions in the river now produced by the discharge of these wastes.

The experiments further indicate that by the use of bleach it may be practicable to reduce materially the color of the waste before its discharge into the river, and such improvement is desirable for obvious reasons.

In carrying out the plans herein proposed, it will be essential that the works be continued under efficient management if the best results are to be secured, and, in the opinion of the Department, it is advisable to filter all of the effluent when practicable, even in the three winter months.

WINCHESTER.

On Aug. 23, 1916, the Department sent the following communication to the Metropolitan Park Commission in response to their request for an examination of the condition of the water of Upper Mystic Lake: —

The results of the examination show that the condition of the lake water is in most respects much the same as that of previous years, but that at the present time it contains a considerable quantity of acid, the acidity of the water of the lake at this point being 1.5 parts per 100,000. The cause of the acidity is the discharge of a large quantity of acid into the Aberjona River near its head waters. The acid has the further effect of imparting a marked color to the water.

In view of the presence of acid in the water, the Department has made a careful investigation and inquiry to determine whether the acid has any effect upon the health of those who use the water for bathing. The results of this investigation do not show that the condition of the water is in any way injurious for bathing at the present time, and in the opinion of the Department there is no present necessity for restricting the use of Mystic Lake for that purpose.

DIVISION OF WATER AND SEWAGE LABORATORIES.

DIVISION OF WATER AND SEWAGE LABORATORIES.

RADIOACTIVITY OF NATURAL WATERS.—TRUE REACTION OF NATURAL WATERS AND THE MODE OF ACTION OF ALUMINIUM SULPHATE AS A PRECIPITANT.

During the year investigations were made by this Division upon two subjects which, while at first thought belonging to pure science, have undoubtedly a more or less practical bearing upon the conditions of waters in ponds and reservoirs, and upon water purification. These two subjects — the radioactivity of natural waters and the true reaction of natural waters — were determined by means not at all usual in sanitary chemical laboratories. This work was carried on for this Division by Mr. Sumner C. Brooks, a graduate student of Harvard University, who has made a specialty of physical chemistry. Mr. Brooks made a lengthy report upon his work and from it these excerpts are taken.

It has been asserted that certain waters are radioactive to an extent that gives them a therapeutic value, and, indeed, waters of a certain spring in Williamstown (Mass.) are said to have such value. This investigation was made, however, with the idea that such radioactive waters, or waters containing radioactive substances, might possibly have an influence upon the growth of algæ in ponds and reservoirs.

Radioactivity consists in the giving off of one or more of three characteristic forms of radiation, and the accompanying transformation of the radioactive element into another chemically distinct element. Its presence has been detected in many elements, and it is possible that all undergo radioactive changes. The radiation consists of alpha, beta and gamma rays. The meaning and definition of these three rays cannot be elaborated here, and it is impossible to discuss in this report the relation of these radiations to our theory of atomic structure further than to say that an atom is supposed to consist of a very dense nucleus occupying about a one thousand million millionth of its total volume, and one or more outer circles of negative electrons. The nucleus consists of positive charges whose number varies according to the position of the element in the periodic table, and from it are derived the alpha particles. It contains, also, a few negative electrons from which arise the beta particles, which on their discharge cause a gamma ray disturbance.

The number of radioactive substances known, the groups into which they are divided, etc., and the rate of change from one substance to another until relatively stable substances are formed, and the life or time of "decay," so called, of radioactive substances, form too complex a subject to be entered into in this report. Nearly all water shows some radioactivity; it has been reported, for example, from dew, sea water, soil water, etc.

Mr. Brooks enters into the discussion of the extremely small unit of measurement, etc., and refers to various investigations on the biological effects of weak radiation. Stoklasa found a stimulation of various bacteria and yeast by an activity in the culture media of 50–2,000 Mache units, equivalent to 0.02–0.08 microcurie per liter. Fabre obtained the maximum stimulation of certain fungi by exposing them for three hours to air containing 0.5 microcurie of emanation per liter of air. There appears to be some evidence of therapeutic value in the relatively weak radiations from certain spring waters.

The apparatus used in this work in regard to the radioactivity of water was a modification of that used by Engler and Sieveking.

A known amount, usually 2 liters, of the water to be investigated was shaken about one-half minute in an air-tight brass can (the equilibrium chamber) of about 12 liters' capacity. This caused the emanation to come into equilibrium in a known ratio between the air and water contained in the equilibrium chamber. This air containing emanation was then passed through a drying tube containing phosphorus pentoxide into a cylindrical brass ionization chamber of about 2,800 cubic centimeters' capacity, which had previously been exhausted to a known pressure (usually 66 centimeters of vacuum), as indicated by a mercury manometer. The air passing out from the equilibrium chamber was replaced by radioactively inert water until the whole system reached atmospheric pressure. The ionization chamber now contained a known proportion (approximately 21.5 per cent. at 22° C.) of the total emanantion in the sample of water.

Projecting into the ionization chamber, and insulated from it by an amber block, was a brass rod whose upper extremity bore the standard to which was attached an aluminium leaf suitably protected from convectional and electrostatic disturbances. This system was positively charged until the mutual repulsion of the charges on the standard and the aluminium leaf caused the latter to stand out at an angle of about 30°. The position of the aluminium leaf could be read with a low-power microscope and ocular micrometer, and the rate of loss of charge determined by the rate of fall of the leaf.

All three types of radiation on passing through a gas cause it to become "ionized," *i.e.*, cause the atoms of the gas to break up, each forming a negative electron and a positively charged residue. These gaseous "ions" will each drift toward an electrode which has a charge opposite to that of the ion; and the gas will then, by the drift of the charged ions, conduct electricity between two oppositely charged bodies. With a sufficient potential gradient, other conditions being equal, the amount of electricity carried will be proportional to the rate at which ions are formed, which is in turn proportional to the amount of the radioactive substance present. The radium emanation in the air taken into the ionization chamber from radioactive water ionizes the air and discharges the aluminium leaf system, the leaf falling as the charge decreases. The fall of the leaf due to spontaneous ionization of the air was determined for each experiment and deducted from the readings obtained.

Examinations of nineteen waters were made, and a table showing the results follows. The work was too meager, of course, for positive conclusions, but it appears that some of the waters examined may perhaps be sufficiently radioactive to accelerate the growth of organisms living in them.

Activity of Various Tap, Well and Pond Waters.

Experiment Number.	Locality.	Source.	Observed Activity; Fall of Aluminium Leaf; Division /Hour.	Initial Activity Microcuries /Liter on Assumption Standard=0.001m.c./L.
10	Fairhaven,	Well, tap in pumping station.	278	0.223
9	Medway,	Well, tap in pumping station.	190	0.210
2	Lawrence, Bay State Building,	Well (232 feet), tap on pump,	328	0.177
14	Springfield, Kibbe Bros.,	Well (352 feet),	325	0.172
I.	Cambridge, Y. M. C. A.,	Well (420 feet),	550	0.167
6	Boston, Eastern Cold Storage Company,	Well (320 feet),	220	0.134
5	Boston, Harvard Medical School,	Well (415 feet),	340	0.131
4	Boston, B. F. Keith's,	Well (350 feet),	316	0.115
III.	Cambridge, Abbott Building,	Well (216 feet),	360	0.110
8	Millbury,	Well, tap in pumping station.	203	0.108
3	Boston, Revere House,	Well (75 feet),	157	0.061
15	Holyoke, Wm. Skinner & Co.,	Well (269 feet),	108	0.058
13	Holyoke, American Thread Company, No. 1 Mill,	Well (300 feet),	112	0.057
7	Framingham, tap in boiler room,	Filter gallery,	120	0.057
12	Springfield, Eastern States Cold Storage Company,	Well (515 feet),	–	–
1	Lawrence, Wood Mill,	Well (450 feet),	–	–
IV.	Cambridge,	Fresh Pond, surface,	–	–
V.	Cambridge,	Fresh Pond, deep,	–	–
VI.	Cambridge,	Tap water,	–	–

THE TRUE REACTION OF NATURAL WATERS AND THE MODE OF ACTION OF ALUMINIUM SULPHATE AS A PRECIPITANT. — THE EXPRESSION OF TRUE REACTION IN TERMS OF HYDROGEN ION CONCENTRATION.

There are two accepted theories at the present time in regard to acidity of natural waters, one attributing the acidity to the amount of CO_2 present in the water, and the other based upon the principle, fundamental in theoretical chemistry, that water and many substances in dilute solution are more or less dissociated into ions which convey positive and negative electricity, and that the carbonates, bicarbonates, carbonic acid and dissolved carbon dioxide are connected with each other and with atmospheric carbon dioxide by a "mobile equilibrium" such that a change in the concentration of any one alters that of all the others.

This study deals almost entirely with the second theory and the measurement of actual acidity or alkalinity of natural waters by determination of the hydrogen ion concentration. The actual acidity of water depends upon the concentration in which positively charged hydrogen ions are present, and the actual alkalinity is determined by the concentration of the hydroxyl ions. The concentration of hydrogen and hydroxyl ions will be equal if the water be absolutely free from all impurities, and the concentration of each at 22° C. will be 1.005/10,000,000 normal; that is, each liter of water will contain 1.005/10,000,000 gram of hydrogen in the ionized condition, and 1.005 x 17/10,000,000 gram of hydroxyl ions.

Hydrogen ion concentrations are usually determined by one of two methods, — the colorimetric or indicator method, and the hydrogen electrode method. Both methods possess characteristic advantages and disadvantages, the former not being easily usable in highly colored liquids, and the latter not being considered reliable in the presence of large quantities of ammonia or of certain specific substances which are said to "poison" the hydrogen electrode. The determination of the actual reaction of potable waters by means of the hydrogen electrode also involves certain technical difficulties, due to the presence of unstable carbonates in the water.

Some work was done with a hydrogen electrode and potentiometer with which the investigator was familiar, but many minor details of technique had to be worked out to eliminate difficulties in the actual working of this process.

It was decided that the investigations should be entirely directed to the investigation of the result, rate and nature of the processes involved in the treatment of natural waters with aluminium sulphate. It became apparent that the hydrogen electrode method was impracticable for this purpose, for the determination of the last two points required the determination of the reaction at frequent intervals immediately subsequent to the introduction of the alum, and this was impossible with a still hydrogen electrode which requires several minutes for one determination, etc.

The colorimetric method was therefore adopted with rather more significant results. The method consists, in brief, in matching the color of the test solution, after addition of a suitable indicator, with that of one of a series of solutions of known hydrogen ion concentrations, in which is placed the same concentration of the same indicator, which presents a series of nuances of color as the hydrogen ion concentration varies over a given range.

Only a few determinations of the reaction of waters after addition of aluminium sulphate were made, as so long a period was necessary for preliminary experimental work and so arranging the apparatus that proper and accurate determinations could be made. All this work is described in the report of the worker mentioned, and diagrams are given showing the titration curve of each water after treatment based upon the titrations made. The work will have to be continued before satisfactory conclusions can be drawn.

From the few experiments made it would appear that the increase in acidity caused by the addition of aluminium sulphate to the waters experimented with was not due to the liberation of carbon dioxide, and for two reasons: (1) the previous nearly complete removal of the free and combined carbon dioxide did not prevent the increase of hydrogen ion concentration, and (2) subsequent removal of carbon dioxide did not result in the decrease of hydrogen ion concentration, which would be expected if carbon dioxide were set free, and as actually occurred in untreated waters. The report finally states: —

> The evidence that the alum precipitation is a colloid reaction, together with the recent discovery of the colloidal nature of the coloring matter in water, opens up a wide field for investigation. These colloidal coloring matters must bear a negative charge if they are to be precipitated by the positive aluminium ion. If the colloids in a water carry a positive charge it is to be expected that the alum will increase rather than neutralize the charge, and no precipitation will result. The magnitude and even the sign of the charge on the colloidal particles may be altered by changes in the reaction of the water. In case alum is not effective as a precipitant because the colloid carries a positive charge, it is possible that a salt of a trivalent anion, such as a tartrate or citrate, might prove effective. It has also been found that rapid addition of an excess of a precipitating ion may result in a reversal of the charge on a colloid before agglomeration can occur, and no precipitation results. Addition of alum in excess might then hinder precipitation.

DIVISION OF FOOD AND DRUGS.

DIVISION OF FOOD AND DRUGS.

TABLE 1. — *Milk from Milk Dealers.*

COUNTY.	Above Standard.	Below Standard.	Total Samples.	Total Solids in Lowest Sample (Per Cent.).	Skimmed Milk sold as Such.	Skimmed Milk sold as Pure Milk.	Watered Milk.	Milk containing Dirt.
Barnstable,	97	22	119	10.60	1	5	-	-
Berkshire,	187	33	220	11.35	-	2	-	-
Bristol,	635	261	896	8.70	2	17	31	-
Dukes,	28	3	31	11.60	-	1	-	-
Essex,	909	245	1,154	9.22	4	18	8	3
Franklin,	39	8	47	11.10	-	-	-	-
Hampden,	270	80	350	8.92	-	6	2	-
Middlesex,	1,509	271	1,780	9.02	4	10	9	-
Nantucket,	31	5	36	11.18	1	1	-	-
Norfolk,	617	110	727	9.20	2	16	11	-
Plymouth,	502	111	613	8.30	-	9	28	4
Suffolk,	299	50	349	9.20	5	5	3	-
Worcester,	539	225	764	8.86	14	19	10	6
Totals,	5,662	1,424	7,086	8.30	33	109	102	13

TABLE 2. — *Milk from Suspected Producers.*

COUNTY.	Above Standard.	Below Standard.	Total Samples.	Total Solids in Lowest Sample (Per Cent.).	Skimmed Milk sold as Pure Milk.	Watered Milk.	Milk containing Dirt.
Barnstable,	4	2	6	12.10	-	-	-
Berkshire,	24	6	30	11.37	1	2	-
Bristol,	10	18	28	7.69	1	9	-
Essex,	70	73	143	9.68	10	11	2[1]
Middlesex,	34	21	55	10.06	-	7	-
Norfolk,	29	27	56	11.04	1	5	-
Plymouth,	27	11	38	8.08	-	8	-
Worcester,	73	50	123	7.70	-	18	11
Totals,	271	208	479	7.70	13	60	13

[1] Contained flies.

TABLE 3. — *Summary of Milk Statistics.*

MILK.	Above Standard.	Below Standard.	Total.	Total Solids in Lowest Sample (Per Cent.).	Skimmed Milk sold as Such.	Skimmed Milk not marked.	Watered Milk.	Milk containing Dirt.
Milk from counties,	5,662	1,424	7,086	8.30	33	109	102	13
Milk from suspected producers.	271	208	479	7.70	-	13	60	13
Miscellaneous samples,	250	143	393	8.54	-	1	13	-
Totals,	6,183	1,775	7,958	7.70	33	123	175	26

TABLE 4. — *Milk Statistics by Months.*[1]

MONTH.	Number above Standard.	Number below Standard.	Total Samples collected.	Skimmed Samples marked.	Skimmed Samples not marked.	Watered Samples.	Samples containing Dirt.	NUMBER OF SAMPLES WITH SOLIDS VARYING BETWEEN —								
								15 Per Cent. and above.	14 and 15 Per Cent.	13 and 14 Per Cent.	12.15 and 13 Per Cent.	11 and 12.15 Per Cent.	10 and 11 Per Cent.	9 and 10 Per Cent.	8 and 9 Per Cent.	Below 8 Per Cent.
1915.																
December,	427	55	482	3	4	4	1	11	33	155	228	48	4	3	–	–
1916.																
January,	126	36	162	–	2	3	–	2	3	31	90	33	3	–	–	–
February,	128	36	164	–	1	4	–	–	2	26	100	33	2	1	–	–
March,	380	81	461	1	12	4	–	5	12	85	277	73	4	2	1	2
April,	543	251	794	2	9	13	2	5	22	104	411	234	8	8	2	–
May,	578	212	790	3	9	21	–	6	14	131	425	180	22	9	3	–
June,	731	137	868	2	18	9	–	11	28	173	517	124	10	4	–	1
July,	651	246	897	4	14	18	1	14	30	210	397	230	13	3	–	–
August,	602	288	890	3	25	31	2	4	17	150	431	253	29	3	3	–
September,	623	110	733	2	9	21	–	8	24	135	455	92	10	5	4	–
October,	783	190	973	2	28	25	–	3	17	213	548	167	14	10	1	–
November,	482	100	582	3	7	23	3	8	28	147	297	79	10	8	5	–
Totals,	6,054	1,742	7,796	27	138	176	9	77	230	1,560	4,176	1,546	129	56	19	3

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[1] Includes samples collected by inspectors only.

TABLE 4. — *Milk Statistics by Months* — Concluded.

MONTH.	Number.	AVERAGE OF ALL SAMPLES.			Number.	AVERAGE OF ALL SAMPLES NOT DECLARED SKIMMED OR WATERED.		
		Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).		Solids (Per Cent.).	Fat (Per Cent.).	Solids not Fat (Per Cent.).
1915.								
December,	482	12.90	3.79	9.11	471	12.95	3.83	9.12
1916.								
January,	162	12.58	3.67	8.91	157	12.63	3.70	8.93
February,	164	12.48	3.58	8.90	159	12.57	3.61	8.96
March,	461	12.59	3.63	8.96	444	12.66	3.68	8.98
April,	794	12.41	3.59	8.82	770	12.47	3.62	8.85
May,	790	12.43	3.61	8.82	757	12.53	3.66	8.87
June,	868	12.66	3.71	8.95	839	12.70	3.75	8.95
July,	897	12.59	3.76	8.83	861	12.64	3.80	8.84
August,	890	12.38	3.65	8.73	832	12.49	3.70	8.77
September,	733	12.62	3.70	8.92	701	12.70	3.74	8.96
October,	973	12.57	3.57	9.00	918	12.66	3.62	9.04
November,	582	12.70	3.79	8.91	549	12.85	3.85	9.00
Totals,	7,796	12.59	3.68	8.91	7,458	12.66	3.72	8.94

TABLE 5. — *Summary of Statistics of Food exclusive of Milk.*

CHARACTER OF SAMPLE.	Genuine.	Adulterated.	Totals.	CHARACTER OF SAMPLE.	Genuine.	Adulterated.	Totals.
Baking powder,	16	–	16	Ice cream,	308	18	326
Bread,	18	–	18	Jams and jellies,	23	2	25
Butter,	6	3	9	Lard,	19	1	20
Canned goods,	17	1	18	Malt liquor,	1	–	1
Cheese,	3	–	3	Maple sugar,	47	26	73
Cider,	15	7	22	Maple syrup,	13	10	23
Clams and oysters,	23	8	31	Meat products: —			
Cocoa,	9	1	10	Beef,	2	6	8
Coffee,	4	–	4	Beef,[2]	–	11	11
Condensed milk,	13	–	13	Hamburg steak,	57	29	86
Condimental sauces,	12	2	14	Mince meat,	10	–	10
Confectionery,	13	2	15	Pork,[2]	–	15	15
Cream,	127	5	132	Sausages,	441	86	527
Cream of tartar,	1	–	1	Milk shakes,	–	2	2
Eggs,[1]	290	209	499	Molasses,	21	–	21
Egg color,	1	–	1	Nuts,	10	11	21
Fish,	4	–	4	Olive oil,	37	4	41
Fish,[2]	2	3	5	Pickles,	1	–	1
Flavoring extracts: —				Pie filling,	1	–	1
Lemon,	26	5	31	Root beer extract,	1	–	1
Peppermint,	3	–	3	Salad dressing,	1	–	1
Raspberry,	1	–	1	Scallops,	67	41	108
Strawberry,	1	–	1	Shrimp,	20	2	22
Vanilla,	42	6	48	Soft drinks,	13	–	13
Wintergreen,	4	–	4	Spices,	8	–	8
Flour,	1	–	1	Sugar,[3]	–	1	1
Fruit juices: —				Syrup,	4	–	4
Grape,	2	–	2	Vinegar,	35	3	38
Lime,	2	–	2	Yeast,	1	–	1
Honey,	9	–	9	Totals,	1,810	520	2,330
Horse radish,	4	–	4				

[1] Largely taken from cold storage.

[2] Taken from cold storage.

[3] Submitted by citizen; contained small per cent. of cornstarch — accidental adulteration.

TABLE 6. — *Summary of Drug Statistics.*

CHARACTER OF SAMPLE.	Genuine.	Adulterated.	Totals.	CHARACTER OF SAMPLE.	Genuine.	Adulterated.	Totals.
Alcohol,	58	7	65	Spirit of —			
Borax,	1	1	2	Anise,	32	15	47
Denatured alcohol,	20	–	20	Camphor,	112	23	135
Essence of pepsin,	2	–	2	Lemon,	6	–	6
Gin,	1	1	2	Nitrous ether,	54	56	110
Hamamelis water,	8	1	9	Peppermint,	152	42	194
Oils: —				Wintergreen,	8	1	9
Anise,	1	–	1	Tincture of —			
Citronella,	15	–	15	Benzoin,	1	–	1
Olive,	27	3	30	Iodine,	166	25	191
Proprietary medicines,	18	2	20	Zinc ointment,	13	–	13
Quinine pills,	2	–	2	Totals,	697	177	874

TABLE 7. — *Summary of Liquor Statistics.*

LOCALITY.	Beer.	Cider.	Wine.	Distilled Liquors.	Miscellaneous and Remarks.	Totals.
Adams,	–	1	–	–	– –	1
Arlington,	–	–	2	–	– –	2
Beverly,	–	–	2	–	– –	2
Boston,	–	–	9	2	2	13
Everett,	–	1	–	–	– –	1
Lowell,	–	1	–	–	– –	1
Lynn,	–	1	–	–	– –	1
Medford,	1	–	–	–	– –	1
Newburyport,	–	–	–	–	2 (sink drainings),	2
Newton,	1	–	–	–	– –	1
Norwood,	–	4	–	–	1	5
Quincy,	–	–	–	1	– –	1
Reading,	–	1	–	–	– –	1
Salem,	–	1	1	–	2	4
Sharon,	–	–	–	2	– –	2
Shirley,	2	1	–	–	– –	3
Somerville,	–	–	1	–	– –	1
Stoneham,	1	–	1	–	– –	2
Stoughton,	1	–	–	–	– –	1
Taunton,	–	–	–	4	– –	4
Waltham,	–	–	–	1	– –	1
Winthrop,	–	–	–	–	1 – –	1
Totals,	6	11	16	10	8 – –	51

TABLE 8. — *Summary of Poison Statistics.*

CHARACTER OF SAMPLE.	Adams Police.	Boston Police.	Groton Police.	Haverhill Police.	Metropolitan Park Police.	Middlesex County Jail.	Somerville Police.	State Police.	Suffolk County Jail.	Taunton Police.	Wakefield Police.	Waltham Police.	Watch and Ward Society.	Worcester Police.	Totals.
Cocaine and its salts,	–	56	–	–	2	–	–	–	–	–	–	–	–	–	58
Morphine and its salts,	–	80	–	–	–	–	–	1	1	–	–	–	1	–	83
Heroin and its salts,	–	1	–	–	–	1	–	–	–	–	–	–	–	–	2
Morphine tablets or pills,	–	2	–	–	–	–	–	–	–	–	–	–	–	–	2
Heroin tablets or pills,	–	7	–	–	–	–	–	–	–	–	–	–	–	–	7
Morphine derivatives,	–	2	–	–	–	–	–	–	–	–	–	–	–	–	2
Morphine derivative tablets,	–	1	–	1	–	–	–	–	–	–	–	–	–	–	2
Alleged poisons,	1	24	1	–	–	1	1	–	4	1	1	–	–	2	36
Miscellaneous,	–	7	–	–	–	–	–	–	–	–	–	1	–	–	8
Totals,	1	180	1	1	2	2	1	1	5	1	1	1	1	2	200

TABLE 9. — *Summary.*

Requests for extension of time granted,		127
Eggs,	18	
Butter,	2	
Poultry,	14	
Meat,	62	
Fish,	31	
Requests for extension of time not granted,		23
Eggs,	2	
Butter,	1	
Poultry,	2	
Meat,	8	
Fish,	10	
Requests for permission to remove granted,		8
Butter,	1	
Poultry,	2	
Meat,	2	
Fish,	3	
Directed to remove (no requests made),		34
Eggs,	5	
Poultry,	2	
Meat,	10	
Fish,	17	

Requests for Extension of Time on Goods in Cold Storage granted during the Year from Dec. 1, 1915, to Dec. 1, 1916.

[Reason for such extensions being that goods were in proper condition for further storage.]

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Eggs, case,	30[1]	Apr. 12, 1915	Indefinitely[2]	State Department of Health.
Egg whites,	375	July 29, 1915	Oct. 29, 1916	American Egg Company.
Egg whites,	425	July 31, 1915	Oct. 31, 1916	American Egg Company.
Egg whites,	200	Aug. 3, 1915	Nov. 3, 1916	American Egg Company.
Egg whites,	325	Aug. 5, 1915	Nov. 5, 1916	American Egg Company.
Egg whites,	275	Aug. 11, 1915	Nov. 11, 1916	American Egg Company.
Egg whites,	275	June 15, 1915	Sept. 13, 1916	Eisenberg, J.
Egg whites,	275	July 12, 1915	Aug. 12, 1916	Ginter Grocery Company.
Egg whites,	250	July 13, 1915	Sept. 30, 1916	Ginter Grocery Company.
Egg whites,	450	July 14, 1915	Oct. 31, 1916	Ginter Grocery Company.
Egg whites,	375	July 15, 1915	Oct. 15, 1916	Ginter Grocery Company.
Egg whites,	275	July 17, 1915	Oct. 17, 1916	Ginter Grocery Company.
Egg whites,	75	July 19, 1915	Oct. 19, 1916	Ginter Grocery Company.
Egg whites,	200	July 20, 1915	Oct. 20, 1916	Ginter Grocery Company.
Egg whites,	200	July 22, 1915	Oct. 22, 1916	Ginter Grocery Company.
Egg whites,	175	July 28, 1915	Oct. 28, 1916	Ginter Grocery Company.

[1] Dozen.

[2] For experimental purposes.

Requests for Extension of Time on Goods in Cold Storage granted during the Year from Dec. 1, 1915, to Dec. 1, 1916 — Continued.

Article.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Egg whites,	125	Aug. 2, 1915	Nov. 2, 1916	Ginter Grocery Company.
Egg whites,	275	Aug. 4, 1915	Nov. 4, 1916	Ginter Grocery Company.
Butter,	52	May 27, 1915	Aug. 1, 1916	Fowle, Hibbard Company.
Butter,	180	June 8, 1915	July 20, 1916	Hagerty, John J., & Co.
Broilers,	2,017	Apr. 27, 1915	July 27, 1916	Dorr, Arthur E., & Co., Inc.
Chickens,	525	Dec. 9, 1915	Mar. 9, 1917	Barker, Henry H.
Chickens,	200	Oct. 29, 1915	Dec. 31, 1916	Du Pont, Ltd.
Ducks,	145	Jan. 2, 1915	Mar. 2, 1916	Jonas, Floyd E.
Fowl,	188	Oct. 29, 1915	Dec. 31, 1916	Du Pont, Ltd.
Fowl,	941	Jan. 26, 1915	Feb. 26, 1916	Legg, G. M. D., Company.
Fowl,	547	June 28, 1915	Aug. 28, 1916	Osgood, C. H.
Fowl,	389	June 22, 1915	Aug. 22, 1916	Osgood, C. H.
Geese,	184	Dec. 31, 1914	Apr. 22, 1916	Dorr, Arthur E., & Co., Inc.
Guinea chickens,	650	Dec. 26, 1914	Mar. 26, 1916	Dorr, Arthur E., & Co., Inc.
Roosters,	800	June 15, 1915	Aug. 15, 1916	Osgood, C. H.
Roosters,	1,603	June 22, 1915	Aug. 22, 1916	Osgood, C. H.
Roosters,	2,540	June 28, 1915	Aug. 28, 1916	Osgood, C. H.
Squab,	120	Jan. 6, 1915	Apr. 6, 1916	Dorr, Arthur E., & Co., Inc.
Beef,	27,865	Dec. 22, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	26,284	Dec. 26, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	21,548	Dec. 29, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	21,027	Dec. 17, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	23,550	Dec. 18, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	20,029	Dec. 24, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	19,226	Dec. 14, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	36,302	Dec. 15, 1914	Mar. 30, 1916	New England Dressed Meat and Wool Company.
Beef,	29,007	Jan. 5, 1915	Apr. 30, 1916	New England Dressed Meat and Wool Company.
Beef (bull meat),	1,141	Jan. 8, 1915	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (bull meat),	23,000	Dec. 18, 1914	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (bull meat),	1,397	Dec. 23, 1914	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef, crops,	5,416	Jan. 13, 1915	May 13, 1916	Dorr, Arthur E., & Co., Inc.
Beef, crops,	400	Jan. 21, 1915	Mar. 22, 1916	Dorr, Arthur E., & Co., Inc.
Beef, crops,	3,165	Jan. 22, 1915	Mar. 22, 1916	Dorr, Arthur E., & Co., Inc.
Beef, hinds,	2,469	Jan. 20, 1915	Apr. 20, 1916	Eastern Cold Storage Company.
Beef, hinds,	4,750	Feb. 19, 1915	Feb. 19, 1916	New England Dressed Meat and Wool Company.

Requests for Extension of Time on Goods in Cold Storage granted during the Year from Dec. 1, 1915, to Dec. 1, 1916 — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Beef livers, . . .	255	Oct. 19, 1915	Jan. 19, 1917	Dorr, Arthur E., & Co., Inc.
Beef loins, . . .	729	Jan. 19, 1915	Mar. 19, 1916	Dorr, Arthur E., & Co., Inc.
Beef loins, . . .	857	Jan. 20, 1915	Mar. 22, 1916	Dorr, Arthur E., & Co., Inc.
Beef loins, . . .	584	Dec. 7, 1914	Mar. 7, 1916	Dorr, Arthur E., & Co., Inc.
Beef loins, . . .	150	Dec. 8, 1914	Mar. 8, 1916	Dorr, Arthur E., & Co., Inc.
Beef loins, . . .	561	Jan. 19, 1915	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef rumps, . .	840	Dec. 8, 1914	Mar. 8, 1916	Dorr, Arthur E., & Co., Inc.
Beef (shin), . .	3,289	Jan. 8, 1915	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (shin), . .	990	Jan. 8, 1915	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (shin), . .	1,088	Dec. 23, 1914	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (shin), . .	1,312	Dec. 30, 1914	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (shin), . .	2,445	Dec. 31, 1914	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (shin), . .	986	Jan. 1, 1915	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef (shin), . .	1,074	Jan. 4, 1915	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef shoulders, . .	480	Feb. 19, 1915	Apr. 19, 1916	Swift & Co.
Beef shoulders, . .	291	Mar. 20, 1915	May 20, 1916	Swift & Co.
Beef shoulders, . .	711	Feb. 13, 1915	Apr. 13, 1916	Swift & Co.
Beef shoulders, . .	515	Feb. 16, 1915	Apr. 16, 1916	Swift & Co.
Beef stickers, . .	260	Mar. 20, 1915	May 20, 1916	Swift & Co.
Beef stickers, . .	1,956	Feb. 16, 1915	Apr. 16, 1916	Swift & Co.
Beef stickers, . .	2,587	Mar. 6, 1915	May 6, 1916	Swift & Co.
Beef stickers, . .	725	Mar. 12, 1915	May 12, 1916	Swift & Co.
Beef stickers, . .	3,789	Mar. 27, 1915	May 27, 1916	Swift & Co.
Beef stickers, . .	3,481	Feb. 5, 1915	Apr. 5, 1916	Swift & Co.
Beef stickers, . .	2,966	Feb. 20, 1915	Apr. 20, 1916	Swift & Co.
Beef tenderloins, .	375	Dec. 23, 1914	Mar. 30, 1916	Lipsky, Samuel, Company.
Beef top rolls, . .	380	Feb. 16, 1915	Apr. 16, 1916	Swift & Co.
Beef top rolls, . .	1,092	Feb. 20, 1915	Apr. 20, 1916	Swift & Co.
Beef top rolls, . .	1,165	Feb. 6, 1915	Apr. 6, 1916	Swift & Co.
Beef top rolls, . .	500	Feb. 6, 1915	Apr. 6, 1916	Swift & Co.
Beef top rolls, . .	433	Feb. 4, 1915	Apr. 4, 1916	Swift & Co.
Beef top rolls, . .	3,149	Feb. 11, 1915	Apr. 11, 1916	Swift & Co.
Beef under cuts, .	122	Feb. 13, 1915	Apr. 13, 1916	Swift & Co.
Beef under cuts, .	785	Feb. 6, 1915	Apr. 6, 1916	Swift & Co.
Beef under cuts, .	403	Feb. 4, 1915	Apr. 4, 1916	Swift & Co.
Beef under cuts, .	4,737	Feb. 11, 1915	Apr. 11, 1916	Swift & Co.

Requests for Extension of Time on Goods in Cold Storage granted during the Year from Dec. 1, 1915, to Dec. 1, 1916 — Continued.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Calves' livers, . .	280	Apr. 28, 1915	July 28, 1916	Dorr, Arthur E., & Co.
Calves' livers, . .	160	June 21, 1915	Sept. 21, 1916	Dorr, Arthur E., & Co.
Lamb, . . .	720	Nov. 24, 1915	Dec. 31, 1916	Du Pont, Ltd.
Lamb chops, . .	710	Nov. 12, 1915	Dec. 31, 1916	Ginter Grocery Company.
Pork, ...	1,460	Jan. 15, 1915	Mar. 1, 1916	Soracco, T., & Co.
Pork, ...	10,000	Apr. 24, 1915	June 24, 1916	Wattendorf, G. V.
Rabbits, . . .	1,265	Jan. 20, 1915	July 20, 1916	Dorr, Arthur E., & Co., Inc.
Veal, ...	2,370	Oct. 22, 1915	Jan. 22, 1917	Dorr, Arthur E., & Co., Inc.
Miscellaneous meat, .	40	Apr. 24, 1915	May 10, 1916	Ross, John H.
Bass, striped, . .	60	July 31, 1915	Nov. 15, 1916	Commonwealth Ice and Cold Storage Company.
Butterfish, . . .	200	July 28, 1915	Oct. 28, 1916	Commonwealth Ice and Cold Storage Company.
Butterfish, . . .	600	July 30, 1915	Oct. 30, 1916	Commonwealth Ice and Cold Storage Company.
Cod, market, . .	1,000	- -	Nov. 15, 1916	Commonwealth Ice and Cold Storage Company.
Codfish, . . .	2,751	Dec. 4, 1914	Feb. 15, 1916	Shore Fish Company.
Eels, ...	300	July 15, 1915	Oct. 15, 1916	Commonwealth Ice and Cold Storage Company.
Flounders, . . .	1,965	Dec. 1, 1914	Dec. 15, 1915	Rich, A. F., & Co.
Flounders, . . .	280	Dec. 4, 1914	Dec. 15, 1915	Atlas Fish Company.
Flounders, . . .	175	Dec. 4, 1914	Dec. 15, 1915	Atlas Fish Company.
Haddock, . . .	1,100	- -	Nov. 15, 1916	Commonwealth Ice and Cold Storage Company.
Halibut, . . .	300	Oct. 15, 1915	Jan. 15, 1917	Commonwealth Ice and Cold Storage Company.
Halibut, . . .	5,320	Feb. 11, 1915	Apr. 11, 1916	Watts & Cook.
Herring, . . .	1,750	Oct. 14, 1915	Indefinitely[1]	Commonwealth Ice and Cold Storage Company.
Herring, . . .	1,500	Nov. 16, 1915	Indefinitely[1]	Commonwealth Ice and Cold Storage Company.
Herring, . . .	1,000	Dec. 6, 1915	Indefinitely[1]	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	7,000	Aug. 29, 1915	Indefinitely[1]	Burns, John, Company.
Mackerel, . . .	150	June 8, 1915	Aug. 8, 1916	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	1,000	June 8, 1915	Aug. 8, 1916	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	130	July 9, 1915	Nov. 11, 1916	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	1,500	July 10, 1915	Oct. 14, 1916	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	270	July 29, 1915	Nov. 11, 1916	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	85	July 31, 1915	Oct. 31, 1916	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	3,000	Aug. 13, 1915	Nov. 13, 1916	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	900	Aug. 21, 1915	Sept. 20, 1916	Gunsenheimer, A.
Mackerel, . . .	3,650	Dec. 17, 1914	Feb. 3, 1916	Rich, E. A., Company.
Pollock, . . .	16,600	Dec. 3, 1914	Jan. 8, 1916	Busalacchi Brothers.

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[1] Indefinite extension granted on condition that goods be used for bait only and are not to be removed from the warehouse excepting in the presence of a State inspector.

Requests for Extension of Time on Goods in Cold Storage granted during the Year from Dec. 1, 1915, to Dec. 1, 1916 — Concluded.

Article.	Weight (Pounds).	Placed in Storage.	Extension granted to —	Name.
Pollock, ...	1,422	Nov. 30, 1914	Feb. 8, 1916	Rich, H. A , Company.
Sardine herring, .	4,500	Oct. 15, 1915	Jan. 1, 1917	Commonwealth Ice and Cold Storage Company.
Shad, ...	350	June 18, 1915	Sept. 18, 1916	Commonwealth Ice and Cold Storage Company.
Shad, ...	350	June 19, 1915	Sept. 19, 1916	Commonwealth Ice and Cold Storage Company.
Shad, ...	180	– –	Nov. 15, 1916	Commonwealth Ice and Cold Storage Company.

Requests for Extension of Time on Goods in Cold Storage not granted during the Year Dec. 1, 1915, to Dec. 1, 1916.

Article.	Weight (Pounds).	Placed in Storage.	Permission to remove.	Name.
Eggs, dried, . .	1,250	Aug. 1, 1914	Dec. 31, 1915[1]	Campbell, E. C., Company.
Egg whites, . .	250	June 15, 1915	Sept. 19, 1916[1]	Eisenberg, Joseph.
Butter, . . .	192	Sept. 25, 1914	Dec. 30, 1915[2]	Legg, George, Poultry Company.
Geese, . . .	205	Dec. 31, 1914	Dec. 31, 1915[2]	Dorr, Arthur E., & Co., Inc.
Turkeys, . . .	178	Dec. 26, 1914	Jan. 10, 1916[2]	Farnsworth, Benjamin & Mills.
Beef, forequarters, .	12,635	Jan. 14, 1915	Jan. 17, 1916[2]	Mentzer, Walter C., Company.
Beef, hindquarters, .	13,400	Jan. 14, 1915	Jan. 17, 1916[2]	Mentzer, Walter C., Company.
Beef stickers, . .	4,335	Apr. 17, 1915	Apr. 27, 1916[2]	Swift & Co.
Beef trimmings, .	335	Feb. 24, 1915	Feb. 14, 1916[3]	Lipsky, Samuel, & Co.
Beef trimmings, .	4,448	Feb. 9, 1915	Feb. 14, 1916[3]	Lipsky, Samuel, & Co.
Calves' heads, . .	235	May 5, 1915	May 18, 1916[2]	Dorr, Arthur E., & Co., Inc.
Mutton neck bones, .	1,615	Dec. 19, 1914	Dec. 28, 1915[2]	Dorr, Arthur E., & Co., Inc.
Pork cheeks, . .	550	Jan. 5, 1915	May 24, 1916[2]	Dorr, Arthur E., & Co., Inc.
Flats, ...	650	Dec. 2, 1914	Dec. 15, 1915[2]	Rich, H. A., Company.
Halibut, . . .	6,025	Nov. 16, 1914	Jan. 20, 1916[4]	Atlas Fish Company.
Halibut, . . .	2,291	Oct. 29, 1914	Jan. 20, 1916[4]	Atlas Fish Company.
Halibut, . . .	250	Nov. 7, 1914	June 3, 1916[4]	Commonwealth Ice and Cold Storage Company.
Halibut, . . .	300	Feb. 11, 1915	June 1, 1916[4]	Commonwealth Ice and Cold Storage Company.
Halibut, . . .	1,060	Dec. 10, 1914	Dec. 30, 1915[2]	Rich, H. A., Company.
Herring, . . .	200	Feb. 24, 1915	June 1, 1916[4]	Commonwealth Ice and Cold Storage Company.
Mackerel, . . .	783	Dec. 7, 1914	Dec. 30, 1915[2]	Rich, H. A., Company.
Salmon, . . .	300	Jan. 29, 1915	– –[5]	Commonwealth Ice and Cold Storage Company.
Tom cod, . . .	8,000	Apr. 15, 1915	Feb. 18, 1916[4]	O'Brien, R., & Co.

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[1] Second request.

[2] Not in proper condition for further storage.

[3] Not in proper condition for further storage. Partly confiscated.

[4] Previously stored.

[5] Confiscated May 26, 1916. Not in proper condition for further storage.

Requests for Permission to remove Articles which had been in Cold Storage longer than Twelve Months granted during the Year Dec. 1, 1915, to Dec. 1, 1916.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Permission to remove.	Name.
Butter, . . .	60	July 17, 1915	Aug. 1, 1916	Chapin & Adams.
Geese, . . .	184	Dec. 31, 1914	June 3, 1916	Boston Terminal Refrigerating Company.[1]
Turkeys, . . .	211	Dec. 24, 1914	Mar. 6, 1916	Legg, G. M. D., Company.
Beef, boned, . .	2,550	Jan. 30, 1915	Feb. 11, 1916	Mindick, M., Company.
Mutton chops, . .	64	Jan. 25, 1915	June 3, 1916	Boston Terminal Refrigerating Company.
Butterfish, . . .	3,900	July 27, 1914	Jan. 18, 1916[2]	Burns, John, Company.
Cusk, ...	2,550	Oct. 16, 1914	Mar. 23, 1916	Goodspeed, L. B., & Co.
Pollock, . . .	700	Feb. 16, 1915	Apr. 5, 1916	Goodspeed, L. B., & Co.

[1] Extension previously granted to Arthur E. Dorr & Co., Inc.; warehouse records reported out.

[2] This lot held pending a court case.

Articles which had been in Cold Storage longer than Twelve Months, and on which no Request for Extension had been made, ordered removed during the Year Dec. 1, 1915, to Dec. 1, 1916.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Directed to remove.	Name.
Eggs, ...	25	July 28, 1915	Aug. 12, 1916	American Egg Company.
Eggs, ...	75	July 29, 1915	Aug. 12, 1916	American Egg Company.
Eggs, ...	70	July 15, 1915	Aug. 12, 1916	American Egg Company.
Eggs, ...	75	July 16, 1915	Aug. 12, 1916	American Egg Company.
Eggs, ...	175	Aug. 3, 1915	Aug. 15, 1916	Brown, M.
Chickens, . . .	35	Oct. 9, 1915	Oct. 21, 1916	Brigham, A. A.
Chickens, . . .	660	Sept. 28, 1915	Oct. 13, 1916	Osgood, C. H.
Beef livers, . .	400	Nov. 2, 1915	Nov. 20, 1916	Walden, E. G.
Beef livers, . .	180	Sept. 9, 1915	Oct. 13, 1916	Wheeler, T. H., Company.
Beef rounds, . .	682	Feb. 16, 1915	Apr. 5, 1916	Dorr, Arthur E., & Co., Inc.
Calves' plucks, . .	160	May 1, 1915	May 13, 1916	Dorr, Arthur E., & Co., Inc.
Lamb kidneys, . .	140	Oct. 9, 1914	Jan. 13, 1916	Batchelder & Snyder Company.
Lamb kidneys, . .	34	Sept. 23, 1914	Jan. 13, 1916	Batchelder & Snyder Company.
Lamb kidneys, . .	126	Dec. 30, 1914	Jan. 20, 1916	Batchelder & Snyder Company.
Lamb kidneys, . .	335	Dec. 2, 1914	Jan. 20, 1916	Batchelder & Snyder Company.
Mutton, . . .	80	June 27, 1915	Oct. 23, 1916	Humphrey, J. L., Jr.
Pork kidneys, . .	30	Oct. 26, 1915	Nov. 15, 1916	Carson, Rubin.

Articles which had been in Cold Storage longer than Twelve Months, and on which no Request for Extension had been made, ordered removed during the Year Dec. 1, 1915, to Dec. 1, 1916 — Concluded.

ARTICLE.	Weight (Pounds).	Placed in Storage.	Directed to remove.	Name.
Butterfish, ...	151	July 19, 1914	May 22, 1916[1]	Phillips, B. F.
Capons, ...	45	Mar. 13, 1915	Mar. 31, 1916	Seaver, I. A.
Flounders, ...	210	Dec. 4, 1914	Dec. 18, 1915	Commonwealth Ice and Cold Storage Company.
Halibut, ...	6,782	Oct. 29, 1914	Mar. 17, 1916	Burns, John, Company.
Halibut, ...	1,501	Oct. 29, 1914	Mar. 17, 1916	Goodspeed, L. B., & Co.
Halibut, ...	675	Jan. 20, 1915	Mar. 17, 1916	Prior, P. H.
Herring, ...	200	Nov. 25, 1914	Dec. 16, 1915	Goodspeed, L. B., & Co.
Lakefish, ...	400	May 8, 1915	May 19, 1916[2]	Krantzman, M.
Mackerel, ...	3,000	Aug. 13, 1915	Aug. 25, 1916	Atkins, M.
Mackerel, ...	2,080	Dec. 31, 1914	Mar. 17, 1916	Goodspeed, L. B., & Co.
Mackerel, ...	745	Feb. 10, 1915	Apr. 5, 1916	Goodspeed, L. B., & Co.
Mackerel, ...	135	July 10, 1914	Apr. 5, 1916	Goodspeed, L. B., & Co.
Salmon, ...	330	July 6, 1915	July 22, 1916	Coleman & Son & Co.
Salmon, ...	315	July 10, 1914	Apr. 5, 1916	Goodspeed, L. B., & Co.
Scup, ...	175	May 15, 1915	June 10, 1916	Puccia, A.
Scrod haddock, . .	1,800	Dec. 22, 1914	Mar. 17, 1916	Goodspeed, L. B., & Co.
Smelts, ...	750	Jan. 15, 1915	Mar. 17, 1916	Goodspeed, L. B., & Co.

[1] Confiscated June 7, 1916.

[2] Confiscated May 19, 1916.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916.*

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
Abington,	58	229	451	-	3 tuberculosis, 1 ulcerative pericarditis.	2 immature, 1 bruised,	1 tuberculosis, 1 emaciation, 1 injured.	-
Acton,	494	832	231	41	6 tuberculosis, 1 poisoning,	50 immature,	2 mange, 3 poisoning,	-
Acushnet,	18	214	380	-	1 tuberculosis,	-	1 tuberculosis,	-
Adams,	27	599	298	18	1 tuberculosis,	4 immature, 1 emaciation,	-	6 wounded.
Agawam,	1,025	903	117	183	4 tuberculosis, 1 mastitis,	3 immature,	3 tuberculosis, 1 sexual odor,	-
Alford,	100	42	46	78	1 tuberculosis,	-	-	1 abdominal abscesses.
Amesbury,	10	57	197	1	1 tuberculosis,	-	1 cirrhosis of liver,	-
Amherst,	19	57	249	-	1 septicæmia,	-	-	-
Andover,	1	15	183	-	-	-	1 tuberculosis,	-
Arlington,	-	2,196	39	20	-	7 immature,	-	-
Ashburnham,	11	61	118	7	-	1 poisoning,	-	-
Ashby,	263	861	274	-	8 tuberculosis, 1 indigestion,	-	1 gastritis,	-
Ashfield,	103	31	412	38	1 tuberculosis,	-	-	-
Ashland,	8	32	296	1	1 parturient apoplexy,	2 immature,	1 tuberculosis,	-
Athol,	159	235	442	19	8 tuberculosis,	1 immature,	1 tuberculosis, 3 hog cholera.	-
ATTLEBORO,	276	278	667	-	2 tuberculosis,	2 emaciation,	5 hog cholera, 2 abdominal abscesses, 1 pyemic anæmia.	-
Auburn,	325	473	168	-	4 tuberculosis, 1 septicæmia, 3 parturient apoplexy.	5 immature,	-	-
Avon,	-	3	91	-	-	-	-	-

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916* — Continued.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
Ayer,	5	9	54	–	–	–	–	–
Barnstable,	26	135	403	–	–	3 immature,	–	–
Barre,	15	33	98	16	–	–	–	–
Becket,	21	20	56	32	–	–	–	–
Bedford,	1	–	154	–	–	–	1 hog cholera, 1 emaciation, 1 anæmia.	–
Belchertown,	80	397	394	–	2 tuberculosis,	2 immature,	1 traumatic pericarditis,	–
Bellingham,	1	2	64	–	–	–	–	–
Belmont,[1]	–	–	43	–	–	–	–	–
Berkley,	–	–	118	3	–	–	–	–
Berlin,	24	33	176	10	–	–	–	–
Bernardston,	62	165	154	32	–	–	–	–
BEVERLY,	–	–	14	–	–	–	–	–
Billerica,	92	238	367	–	14 tuberculosis,	10 immature, 1 tuberculosis.	1 tuberculosis,	–
Blackstone,[2]	–	24	30	–	–	–	–	–
Blandford,	15	38	122	40	–	–	–	–
Bolton,	4	3	83	–	–	–	–	–
Bourne,	5	27	142	–	–	–	–	–
Boxborough,	2	379	45	–	–	–	–	–
Boxford,	191	435	180	2	1 died otherwise than by slaughter.	10 immature, 2 died otherwise than by slaughter.	–	–
Boylston,	53	261	296	7	1 tuberculosis,	–	–	–

Braintree, ...	49	619	493	–	4 tuberculosis, 2 pneumonia, 1 indigestion, 1 hemorrhage, 2 advanced pregnancy, 1 poisoning.	2 exposure, . . .	8 lacerated,	–	–
Brewster, ...	13	35	86	–	– –	1 immature, . . .	– –	–	–
Bridgewater, . . .	7	7	232	–	– –	– –	– –	–	–
Brimfield, ...	2	41	121	–	– –	– –	– –	–	–
Brockton, . . .	495	325	358	8	11 tuberculosis, . . .	15 immature, . . .	– –	–	–
Brookfield, . . .	12	155	253	52	– –	– –	– –	–	–
Brookline, ...	–	–	–	–	– –	– –	– –	–	–
Buckland,[1] . . .	2	–	8	1	– –	– –	– –	–	–
Burlington, . . .	–	6	941	–	– –	– –	– –	–	–
Cambridge, . . .	4	12,519	–	–	– –	455 immature, 2 jaundice, 15 diarrhœa, 1 phlebitis, 49 weak condition, 24 bruised.	– –	–	–
Canton, ...	–	1	205	2	– –	– –	– –	–	–
Carlisle, ...	1	1	10	–	– –	– –	– –	–	–
Carver, ...	103	319	23	2	– –	8 immature, . . .	– –	–	–
Charlemont, . . .	33	6	120	15	– –	– –	– –	–	–
Charlton, ...	332	920	285	4	3 tuberculosis, 1 injured, .	– –	– –	–	–
Chatham, ...	3	9	124	1	– –	– –	– –	–	–
Chelmsford, . . .	376	638	1,735	17	5 tuberculosis, 1 advanced pregnancy, 1 improperly bled, 2 died otherwise than by slaughter.	11 immature, . . .	5 hog cholera, 1 septicæmia, 2 improperly bled, 2 died otherwise than by slaughter.	–	–
Chelsea, ...	–	–	–	–	– –	– –	– –	–	–
Cheshire, ...	50	154	278	–	1 tuberculosis, . . .	– –	– –	–	–
Chester, ...	15	85	107	2	– –	1 polyarthritis, . . .	1 tuberculosis, . . .	–	–
Chesterfield, . . .	37	56	189	6	– –	– –	1 tuberculosis, . . .	–	–

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[1] Report for one quarter not made.

[2] Reports for two quarters not made.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916* — Continued.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
CHICOPEE,	44	23	652	6	1 tuberculosis,	-	2 tuberculosis, 1 enteritis, 1 lacerated.	-
Chilmark,	6	7	21	69	-	-	-	-
Clarksburg,	120	173	204	3	-	-	-	-
Clinton,	131	592	96	15	3 tuberculosis, 1 pericarditis, purulent, 1 pericarditis, traumatic.	7 immature,	-	-
Cohasset,	1	9	145	-	-	-	1 tuberculosis,	-
Colrain,	46	26	275	-	1 tuberculosis,	-	-	-
Concord,	39	194	14	-	-	21 immature,	-	-
Conway,	35	42	120	25	-	-	-	1 tumors.
Cummington,	25	90	193	4	-	-	-	-
Dalton,	36	39	150	-	-	-	-	-
Dana,	4	1	54	-	-	-	-	-
Danvers,	-	344	10	-	-	-	-	-
Dartmouth,	9	219	763	5	-	4 immature,	-	-
Dedham,	6	534	654	1	1 tuberculosis, 1 pneumonia.	1 immature,	1 tuberculosis, 1 pneumonia, 20 hog cholera.	-
Deerfield,	35	37	478	15	-	-	1 tuberculosis,	-
Dennis,	11	35	151	-	-	-	1 tuberculosis,	-
Dighton,	333	327	152	78	2 tuberculosis,	-	-	-
Douglas,	3	63	82	-	-	-	3 tuberculosis,	-
Dover,	-	-	26	-	-	-	-	-
Dracut,	1,677	1,254	1,425	2	17 tuberculosis, 1 dropsy,	29 immature, 2 diarrhœa,	3 tuberculosis, 36 hog cholera.	-

Dudley,	227	313	326	–	3 tuberculosis,	–	–	–	–
Dunstable,	2	4	33	4	–	–	–	–	–
Duxbury,	1	10	132	–	–	–	–	–	–
East Bridgewater,	13	296	191	8	–	–	–	–	–
East Longmeadow,	26	13	263	–	–	–	–	–	–
Eastham,	9	41	59	–	–	–	–	–	–
Easthampton,	28	655	258	–	–	1 internal injuries,	2 tuberculosis,	–	–
Easton,	55	421	36	–	–	–	1 tuberculosis,	–	–
Edgartown,	6	27	213	36	–	–	–	–	–
Egremont,	47	83	94	49	–	–	1 unstamped,	–	–
Enfield,	3	574	110	–	–	–	–	–	–
Erving,	12	12	62	–	–	–	–	–	–
Essex,[1]	–	–	37	–	–	–	1 tuberculosis,	–	–
EVERETT,	–	–	–	–	–	–	–	–	–
Fairhaven,	1,450	1,260	177	23	41 tuberculosis, 3 parturient apoplexy.	33 immature, 7 emaciation,	1 tuberculosis,	–	–
FALL RIVER,	–	–	–	–	–	–	–	–	–
Falmouth,[2]	7	35	385	–	1 tuberculosis,	–	1 tuberculosis, 1 pyæmia,	–	–
FITCHBURG,	886	1,748	358	29	16 tuberculosis, 1 pericarditis.	15 immature, 4 weak condition.	–	–	–
Florida,	11	57	71	–	–	–	–	–	–
Foxborough,	7	42	12	–	–	–	–	–	–
Framingham,	87	299	90	6	9 tuberculosis,	4 immature,	–	–	–
Franklin,	–	31	315	–	–	–	1 tuberculosis,	–	–
Freetown,	14	13	97	4	–	–	–	–	–
Gardner,	338	502	295	4	20 tuberculosis, 1 peritonitis,	25 immature,	1 tuberculosis, 2 hog cholera,	–	–

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[1] Report for one quarter not made.

[2] Reports for two quarters not made.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916* — Continued.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
Gay Head,[1]	-	-	-	-	-	-	-	-
Georgetown,	5	7	31	13	4 tuberculosis,	-	-	-
Gill,	26	41	158	10	-	-	-	-
GLOUCESTER,	70	196	170	-	2 tuberculosis,	7 immature,	-	-
Goshen,	30	71	39	-	-	-	-	-
Gosnold,	3	-	11	-	-	-	-	-
Grafton,	9	228	531	2	1 tuberculosis,	-	1 tuberculosis, 4 hog cholera.	-
Granby,	425	572	66	-	1 tuberculosis,	-	-	-
Granville,	12	38	143	4	-	-	-	-
Great Barrington,	34	257	439	72	4 tuberculosis,	-	-	-
Greenfield,	105	252	279	285	4 tuberculosis, 1 prolapsus uteri.	-	3 tuberculosis,	1 anæmia.
Greenwich,	32	93	107	1	-	-	-	-
Groton,	3	3	138	-	-	-	-	-
Groveland,	-	-	3	-	-	-	-	-
Hadley,	67	106	332	-	4 tuberculosis,	-	3 tuberculosis,	-
Halifax,	-	-	10	-	-	-	-	-
Hamilton,	-	-	9	-	-	-	-	-
Hampden,	4	172	79	-	-	-	-	-
Hancock,	24	186	21	98	1 tuberculosis,	1 tuberculosis,	-	-
Hanover,	1	18	230	4	-	-	-	-

Hanson, ...	–	3	86	–	–	–	–	–	–	–	–	–
Hardwick, ...	101	271	253	23	–	–	–	–	–	–	–	–
Harvard,[2] . . .	14	227	96	5	–	–	–	–	–	–	–	–
Harwich, ...	12	48	151	–	–	–	–	–	1 tuberculosis, . . .		–	–
Hatfield, ...	29	151	449	–	9 tuberculosis, . . .		–	–	–	–	–	–
HAVERHILL,[3] . . .	–	–	–	–	–	–	–	–	–	–	–	–
Hawley, ...	17	6	81	18	–	–	–	–	–	–	–	–
Heath, ...	24	24	53	–	–	–	–	–	–	–	–	–
Hingham, ...	3	2	229	–	–	–	–	–	–	–	–	–
Hinsdale, ...	33	78	146	3	2 tuberculosis, . . .		1 tuberculosis, . . .		–	–	–	–
Holbrook, ...	–	–	24	–	–	–	–	–	1 tuberculosis, . . .		–	–
Holden,[2]	55	191	149	–	–	–	–	–	–	–	–	–
Holland, ...	4	13	28	3	–	–	–	–	–	–	–	–
Holliston, ...	341	1,237	86	2	3 tuberculosis, . . .		12 immature, 1 tuberculosis.		–	–	–	–
HOLYOKE,[3] . . .	3	1	16	–	–	–	–	–	–	–	–	–
Hopedale, ...	–	–	15	–	–	–	–	–	–	–	–	–
Hopkinton, ...	4	44	119	–	1 tuberculosis, . . .		–	–	–	–	–	–
Hubbardston, . . .	13	143	101	–	1 tuberculosis, . . .		–	–	1 tuberculosis, . . .		–	–
Hudson, ...	2	52	226	1	–	–	–	–	2 tuberculosis, 1 hog cholera.		–	–
Hull, ...	–	–	7	–	–	–	–	–	–	–	–	–
Huntington,[3] . . .	29	72	149	68	–	–	–	–	–	–	–	–
Ipswich, ...	3	7	231	–	1 injured, ...		–	–	1 poisoning, . . .		–	–

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[1] No reports made.

[2] Report for one quarter not made.

[3] Reports for two quarters not made.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916* — Continued.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
Kingston,	1	30	101	-	-	-	1 emaciation,	-
Lakeville,	1	-	94	-	-	-	-	-
Lancaster,	2	2	135	1	-	-	-	-
Lanesborough,	77	89	387	-	3 tuberculosis,	-	-	-
LAWRENCE,	176	418	2,327	17	5 tuberculosis, 1 parturient apoplexy, 1 emaciation.	2 immature,	1 jaundice, 2 abscesses, 2 tumors, 10 measles, 3 parturient apoplexy, 2 emaciation, 1 sexual odor, 1 bruised.	-
Lee,	94	173	370	-	-	-	-	-
Leicester,	84	581	203	-	2 tuberculosis, 1 parturient apoplexy.	-	1 cirrhosis of liver,	-
Lenox,	242	327	280	30	1 ulcers of liver, 1 parturient apoplexy.	2 immature,	1 bruised,	-
LEOMINSTER,	97	534	570	2	6 tuberculosis,	17 immature,	8 tuberculosis, 2 pneumonia.	-
Leverett,[1]	18	13	185	-	-	-	-	-
Lexington,	93	1,068	2,512	8	25 tuberculosis,	14 immature, 2 stillborn,	-	-
Leyden,	58	100	136	9	-	-	-	-
Lincoln,	40	82	815	-	1 retained fœtus, 3 strangulation.	3 immature,	1 pneumonia, 9 hog cholera,	-
Littleton,[2]	-	-	11	-	-	-	-	-
Longmeadow,	2	6	42	-	-	-	-	-
LOWELL,	-	-	725	-	-	-	6 tuberculosis, 2 hog cholera, 3 septic wounds, 2 emaciation.	-
Ludlow,	27	888	207	18	1 weak condition,	1 immature,	-	-
Lunenburg,	359	782	601	2	7 tuberculosis,	4 immature,	2 tuberculosis, 1 hog cholera.	-

LYNN,	239	164	259	-	-	-	-	-	-	-	-	-
Lynnfield,	85	218	-	-	-	-	2 immature,		-	-	-	-
MALDEN,[2]	-	-	-	-	-	-	-	-	-	-	-	-
Manchester,[1]	-	-	8	-	-	-	-	-	-	-	-	-
Mansfield,	32	59	456	-	-	-	1 tuberculosis,		2 tuberculosis,		-	-
Marblehead,	1	-	122	-	-	-	-	-	-	-	-	-
Marion,	-	5	100	-	-	-	-	-	-	-	-	-
MARLBOROUGH,	22	165	389	13	4 tuberculosis, 1 exhaustion, 1 bruised.		3 immature,		6 tuberculosis,		-	-
Marshfield,	5	8	172	-	-	-	-	-	-	-	-	-
Mashpee,	2	-	21	-	-	-	-	-	-	-	-	-
Mattapoisett,	-	20	203	2	-	-	-	-	1 tuberculosis,		-	-
Maynard,	33	256	347	-	4 tuberculosis, 1 pulmonary congestion, 1 intestinal obstruction, 1 difficult parturition, 1 illegally slaughtered.		5 immature,		2 hog cholera,		-	-
Medfield,	2	3	124	1	-	-	-	-	-	-	-	-
MEDFORD,	-	-	-	-	-	-	-	-	-	-	-	-
Medway,[2]	1	7	142	5	-	-	-	-	-	-	-	-
MELROSE,	-	-	4	-	-	-	-	-	-	-	-	-
Mendon,	5	34	77	-	-	-	-	-	-	-	-	-
Merrimac,	22	19	90	-	-	-	-	-	1 tuberculosis,		-	-
Methuen,	1,018	495	590	10	32 tuberculosis, 1 difficult parturition, 1 injured.		37 immature, 1 illegally slaughtered, 1 died otherwise than by slaughter.		5 tuberculosis,		-	-
Middleborough,[2]	166	318	176	2	1 tuberculosis,		-	-	-	-	-	-
Middlefield,[1]	-	-	-	-	-	-	-	-	-	-	-	-
Middleton,	77	263	41	2	18 tuberculosis,		-	-	-	-	-	-

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[1] Reports for two quarters not made.

[2] Report for one quarter not made.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916* — Continued.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
Milford,	327	636	869	5	9 tuberculosis, 1 pneumonia.	39 immature,	1 tuberculosis,	-
Millbury,	-	72	137	-	-	-	-	-
Millis,	171	272	14	14	1 tuberculosis,	2 diarrhœa,	-	-
Milton,	-	-	44	17	-	-	-	-
Monroe,	10	11	23	4	-	-	-	-
MONSON,	49	130	211	-	1 tuberculosis,	-	3 tuberculosis,	-
Montague,	237	290	338	11	1 poisoning,	-	1 fever,	-
Monterey,	85	259	159	42	1 tuberculosis, 1 actinomycosis, 1 prolapsus uteri.	-	-	-
Montgomery,	12	85	28	33	1 tuberculosis,	-	-	-
Mount Washington,[1]	-	-	-	-	-	-	-	-
Nahant,[2]	-	-	-	-	-	-	-	-
Nantucket,	-	66	206	26	-	-	-	-
Natick,	-	1	6	-	-	-	-	-
Needham,[3]	-	-	-	-	-	-	-	-
New Ashford,	2	16	21	44	-	-	-	-
NEW BEDFORD,	130	295	498	15	20 tuberculosis,	4 immature,	1 pneumonia,	-
New Braintree,	51	543	54	1	-	-	-	-
New Marlborough,	31	52	196	23	-	-	-	-
New Salem,	30	70	119	1	-	-	-	-
Newbury,	47	522	395	34	2 tuberculosis, 1 emaciation,	33 immature,	-	-

NEWBURYPORT,	365	886	460	–	1 tuberculosis,		5 immature,		–	–	–	–
NEWTON,	–	–	21	–	–	–	–	–	–	–	–	–
Norfolk,	–	3	131	3	–	–	–	–	–	–	–	–
NORTH ADAMS,	427	447	569	13	2 tuberculosis,		–	–	–	–	–	–
North Andover,	8	97	168	1	–	–	–	–	1 tuberculosis,		–	–
North Attleborough,	201	237	234	–	5 tuberculosis,		1 abdominal abscesses,		1 tuberculosis,		–	–
North Brookfield,	20	181	139	4	1 tuberculosis,		1 immature,		–	–	–	–
North Reading,	8	65	72	–	–	–	–	–	1 hog cholera,		–	–
NORTHAMPTON,	205	586	348	–	21 tuberculosis,		–	–	–	–	–	–
Northborough,	6	40	80	–	–	–	–	–	–	–	–	–
Northbridge,	1	24	137	–	–	–	–	–	–	–	–	–
Northfield,	56	42	275	12	3 tuberculosis,		–	–	–	–	–	–
Norton,	68	93	26	1	–	–	–	–	–	–	–	–
Norwell,	4	51	414	18	–	–	–	–	2 tuberculosis,		–	–
Norwood,	–	8	97	–	–	–	–	–	–	–	–	–
Oak Bluffs,[1]	–	–	1	–	–	–	–	–	–	–	–	–
Oakham,	8	48	60	7	–	–	–	–	–	–	–	–
Orange,	54	160	442	–	4 tuberculosis,		–	–	4 tuberculosis,		–	–
Orleans,	6	10	59	–	–	–	–	–	–	–	–	–
Otis,	26	80	58	11	–	–	–	–	–	–	–	–
Oxford,	9	51	220	–	–	–	–	–	3 tuberculosis,		–	–
Palmer,	207	168	276	–	3 tuberculosis,		3 immature,		–	–	–	–
Paxton,	24	148	95	–	–	–	–	–	–	–	–	–

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[1] Reports for two quarters not made.

[2] No reports made.

[3] Report for one quarter not made.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916* — Continued.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
PEABODY,	502	1,091	1,847	5	6 tuberculosis,	29 immature,	2 tuberculosis, 63 hog cholera, 1 jaundice, 2 septicæmia.	-
Pelham,	2	10	75	-	-	-	-	-
Pembroke,	5	87	190	3	-	-	-	-
Pepperell,	64	645	429	10	2 tuberculosis, 1 metritis,	4 immature,	2 tuberculosis,	-
Peru,	11	15	67	9	-	-	-	-
Petersham,	24	56	226	16	-	-	1 tuberculosis,	-
Phillipston,	18	56	82	9	1 tuberculosis,	-	-	-
PITTSFIELD,	803	908	1,267	66	8 tuberculosis,	1 tuberculosis, 1 emaciation.	1 tuberculosis,	-
Plainfield,	28	66	138	3	-	-	-	-
Plainville,	-	-	6	-	-	-	-	-
Plymouth,	43	98	526	22	3 tuberculosis,	1 immature,	1 tuberculosis, 1 pneumonia.	-
Plympton,	-	1	36	-	-	-	-	-
Prescott,	11	-	71	-	-	-	-	-
Princeton,	7	3	26	7	-	-	-	-
Provincetown,	2	5	216	-	-	-	1 emaciation,	-
QUINCY,[1]	-	-	-	-	-	-	-	-
Randolph,[2]	-	1	111	-	-	-	-	-
Raynham,	18	86	78	13	1 tuberculosis,	-	-	-
Reading,	606	349	345	1	3 tuberculosis,	14 immature,	4 hog cholera,	-
Rehoboth,	20	1,081	124	-	-	1 diarrhœa,	-	-

REVERE,[2]	-	-	-	-	- -	- -	- -	- -
Richmond, ...	115	138	273	55	1 strangulated hernia, .	- -	- -	- -
Rochester, ...	37	512	442	15	- -	- -	1 injured, ...	- -
Rockland,[3]	-	-	30	-	- -	- -	- -	- -
Rockport, ...	72	259	77	-	- -	- -	- -	- -
Rowe, ...	20	15	63	30	1 hypoderma lineata, .	- -	- -	- -
Rowley, ...	57	270	141	5	1 tuberculosis, . . .	- -	- -	- -
Royalston, ...	26	98	172	57	- -	- -	- -	- -
Russell, ...	8	12	93	-	- -	- -	- -	- -
Rutland,[2]	59	150	87	-	- -	- -	- -	- -
SALEM, ...	-	-	13	-	- -	- -	- -	- -
Salisbury, ...	3	-	159	-	- -	- -	- -	- -
Sandisfield, ...	150	112	145	11	- -	- -	- -	- -
Sandwich, ...	5	96	95	-	- -	- -	- -	- -
Saugus, ...	1	12	140	-	- -	- -	1 tuberculosis, 1 hog cholera.	- -
Savoy, ...	9	38	79	2	- -	- -	- -	- -
Scituate, ...	-	24	52	-	- -	- -	- -	- -
Seekonk, ...	-	4	156	-	- -	- -	2 cellulitis, ...	- -
Sharon, ...	-	4	15	-	- -	- -	- -	- -
Sheffield, ...	44	62	268	30	- -	- -	- -	- -
Shelburne, ...	130	140	341	239	2 tuberculosis, 1 emaciation, 1 injured.	- -	- -	- -
Sherborn, ...	-	8	53	-	- -	- -	- -	- -
Shirley, ...	12	17	225	2	1 tuberculosis, 1 emaciation,	- -	1 tuberculosis, ...	- -

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[1] Reports for two quarters not made.

[2] Report for one quarter not made.

[3] Reports for three quarters not made.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending September 30, 1916* — Continued.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
Shrewsbury,	2,090	2,433	456	13	36 tuberculosis, 1 enteritis,	34 immature, 4 tuberculosis, 3 stillborn.	2 pneumonia, 2 measles,	-
Shutesbury,	4	7	47	-	1 tuberculosis,	-	-	-
Somerset,	2	-	326	-	-	-	-	-
SOMERVILLE,	-	-	169	-	-	-	2 tuberculosis, 1 parturient apoplexy.	-
South Hadley,	273	1,098	360	1	2 tuberculosis,	-	-	-
Southampton,	193	147	229	5	1 tuberculosis,	-	5 tuberculosis,	-
Southborough,[1]	-	-	7	-	-	-	-	-
Southbridge,	45	98	322	-	-	-	-	-
Southwick,	23	97	212	-	-	1 tuberculosis,	1 tuberculosis,	-
Spencer,	18	117	126	16	-	-	-	-
SPRINGFIELD,	3	16	146	5	2 tuberculosis,	-	1 tuberculosis,	3 illegally slaughtered.
Sterling,[2]	50	478	79	12	1 tuberculosis, 1 pleurisy with effusion, 1 septicæmia.	16 immature,	-	-
Stockbridge,	27	85	307	39	-	-	-	-
Stoneham,	-	-	-	-	-	-	-	-
Stoughton,	43	269	56	-	-	-	-	-
Stow,	4	3	2	-	-	-	-	-
Sturbridge,	328	632	89	10	3 tuberculosis,	-	-	-
Sudbury,	-	2	128	-	-	-	-	-
Sunderland,	2	-	50	-	-	-	5 tuberculosis,	-
Sutton,[2]	56	189	124	-	1 tuberculosis,	-	-	-

Swampscott,	-	-	1	-	-	-	-	-
Swansea,	420	534	250	92	9 tuberculosis, 1 abscess, 1 fever.	1 immature, 1 bruised,	1 tuberculosis,	-
TAUNTON,	343	321	1,352	30	9 tuberculosis,	-	4 tuberculosis, 4 hog cholera.	10 nodular disease.
Templeton,	47	106	390	29	1 tuberculosis, 1 parturition.	1 immature, 1 tuberculosis,	1 tuberculosis, 1 abdominal abscesses, 1 septicæmia.	-
Tewksbury,³	261	241	350	3	2 tuberculosis, 1 septicæmia, 1 diabetes.	6 immature,	1 tuberculosis, 1 pneumonia, 1 suffocation.	-
Tisbury,³	-	7	3	-	-	-	-	-
Tolland,	8	30	133	-	-	-	-	-
Topsfield,	7	88	195	3,036	-	2 immature,	-	1 peritonitis.
Townsend,	22	48	113	5	2 tuberculosis,	-	1 hog cholera,	-
Truro,	3	4	82	-	-	-	-	-
Tyngsborough,	-	3	115	-	-	-	-	-
Tyringham,	8	75	82	3	-	-	-	-
Upton,	18	52	70	-	-	-	-	-
Uxbridge,	52	31	207	-	6 tuberculosis,	-	2 tuberculosis, 1 abscess,	-
Wakefield,³	-	-	411	-	-	-	1 tuberculosis, 23 hog cholera.	-
Wales,	2	9	21	-	-	-	-	-
Walpole,	9	9	627	3	-	-	1 tuberculosis, 1 hog cholera, 1 jaundice.	-
WALTHAM,	5	-	79	-	1 tuberculosis,	-	-	-
Ware,	13	40	206	-	-	-	2 illegally slaughtered,	-
Wareham,	7	62	531	-	1 tuberculosis,	-	6 tuberculosis,	-
Warren,	17	84	220	2	1 tuberculosis,	-	-	-
Warwick,	9	29	119	24	-	-	-	-
Washington,	8	99	65	-	-	-	-	-

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¹ Reports for three quarters not made.

² Reports for two quarters not made.

³ Report for one quarter not made.

TABLE 10. — *Report on Inspection of Slaughtering for the Year ending Sept. 30, 1916* — Concluded.

CITY OR TOWN.	INSPECTED.				CONDEMNED.			
	Cattle.	Calves.	Hogs.	Sheep.	Cattle.	Calves.	Hogs.	Sheep.
Watertown,	35	3,957	233	18	1 tuberculosis,	272 immature, 1 died otherwise than by slaughter.	1 tuberculosis, 1 peritonitis,	-
Wayland,	3	26	251	1	1 abdominal abscesses,	-	-	-
Webster,	2	26	214	-	-	-	3 hog cholera,	-
Wellesley,[1]	-	-	-	1	-	-	-	-
Wellfleet,	7	13	51	3	-	-	-	-
Wendell,	15	35	84	24	-	-	-	-
Wenham,[1]	397	659	139	-	7 tuberculosis,	12 immature,	-	-
West Boylston,	4	15	61	-	-	-	-	-
West Bridgewater,	7	591	584	3	1 tuberculosis, 1 intestinal obstruction, 1 prolapsus uteri.	20 immature, 1 tuberculosis, 2 dysentery.	-	-
West Brookfield,	16	67	135	11	-	-	-	-
West Newbury,	-	-	20	12	-	-	-	-
West Springfield,	29	274	206	-	-	1 immature,	-	-
West Stockbridge,	47	71	207	33	1 tuberculosis,	2 tuberculosis,	1 peritonitis,	-
West Tisbury,	17	25	22	243	-	-	-	-
Westborough,	22	43	183	-	-	-	-	-
Westfield,	67	99	380	-	2 tuberculosis, 1 strangulation.	-	-	-
Westford,	33	513	469	5	1 tuberculosis,	9 immature,	1 hog cholera,	-
Westhampton,	42	94	94	-	-	-	2 tuberculosis,	-
Westminster,	47	88	246	-	3 tuberculosis, 1 parturient apoplexy.	-	1 tuberculosis,	-

Weston,	113	343	223	15	1 tuberculosis, 1 pneumonia, 1 ulcer, 1 septicæmia.	27 immature,	-	-	-
Westport,	922	1,624	968	63	1 tuberculosis,	1 immature, 5 bruised,	2 tuberculosis, 1 measles,	-	-
Westwood,	16	352	531	2	-	-	1 hog cholera, 3 emaciation, 2 anæmia.	-	-
Weymouth,	17	375	400	-	5 tuberculosis,	19 immature,	1 tuberculosis,	-	-
Whately,	93	164	56	-	1 tuberculosis,	-	-	-	-
Whitman,	1	9	-	-	-	1 immature,	-	-	-
Wilbraham,	25	32	135	-	2 tuberculosis,	-	-	-	-
Williamsburg,	12	55	176	-	-	-	-	-	-
Williamstown,	57	558	701	237	10 tuberculosis,	-	1 tuberculosis,	-	-
Wilmington,	-	4	336	-	-	-	-	-	-
Winchendon,	23	112	461	1	-	1 immature,	-	-	-
Winchester,[2]	-	-	-	-	-	-	-	-	-
Windsor,	41	125	132	37	-	-	-	-	-
Winthrop,[1]	-	-	-	-	-	-	-	-	-
WOBURN,	24	1,247	4,997	-	2 tuberculosis, 2 enteritis,	36 immature,	1 tuberculosis, 54 pneumonia.	-	-
WORCESTER,	684	801	1,345	39	1 tuberculosis, 1 parturient apoplexy.	12 immature, 1 injured,	10 hog cholera, 2 pneumonia, 1 abscesses.	-	-
Worthington,	26	32	149	12	-	-	-	-	-
Wrentham,	-	8	86	-	-	-	-	-	-
Yarmouth,	-	2	86	-	-	-	-	-	-

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[1] Report for one quarter not made.

[2] No reports made.

Summary of Report on Inspection of Slaughtering.

Total number of carcasses inspected,		197,128
Cattle,	28,547	
Calves,	80,853	
Hogs,	80,909	
Sheep,	6,819	
Total number of carcasses condemned,		2,767
Cattle,	653	
Calves,	1,593	
Hogs,	498	
Sheep,	23	
Total number of carcasses passed,		194,361

Reasons for Condemnation.	Cattle.	Calves.	Hogs.	Sheep.	Totals.
Immaturity,	–	1,441	–	–	1,441
Tuberculosis,	571	15	138	–	724
Actinomycosis,	1	–	–	–	1
Pneumonia,	5	–	65	–	70
Pulmonary congestion,	1	–	–	–	1
Pleurisy with effusion,	1	–	–	–	1
Hog cholera,	–	–	204	–	204
Gastritis,	–	–	1	–	1
Indigestion,	2	–	–	–	2
Enteritis,	3	–	1	–	4
Nodular disease,	–	–	–	10	10
Intestinal obstruction,	2	–	–	–	2
Peritonitis,	1	–	2	1	4
Ulcers of liver,	1	–	–	–	1
Cirrhosis of liver,	–	–	2	–	2
Jaundice,	–	2	3	–	5
Diarrhœa,	–	20	–	–	20
Dysentery,	–	2	–	–	2
Abscesses,	1	–	4	–	5
Abdominal abscesses,	1	1	3	1	6
Tumors,	–	–	2	1	3
Ulcer,	1	–	–	–	1
Strangulated hernia,	1	–	–	–	1
Hemorrhage,	1	–	–	–	1
Hypoderma lineata,	1	–	–	–	1
Septicæmia,	5	–	4	–	9
Septic wounds,	–	–	3	–	3
Pyæmia,	–	–	1	–	1
Phlebitis,	–	1	–	–	1

Reasons for Condemnation.	Cattle.	Calves.	Hogs.	Sheep.	Totals.
Cellulitis, ...	–	–	2	–	2
Mastitis, ...	1	–	–	–	1
Polyarthritis, ...	–	1	–	–	1
Measles, ...	–	–	13	–	13
Mange, ...	–	–	2	–	2
Dropsy, ...	1	–	–	–	1
Diabetes, ...	1	–	–	–	1
Pericarditis, ...	1	–	–	–	1
Pericarditis, purulent, . . .	1	–	–	–	1
Pericarditis, traumatic, . . .	1	–	1	–	2
Pericarditis, ulcerative, . . .	1	–	–	–	1
Fever, ...	1	–	1	–	2
Parturient apoplexy, . . .	12	–	4	–	16
Parturition, ...	1	–	–	–	1
Difficult parturition, . . .	2	–	–	–	2
Advanced pregnancy, . . .	3	–	–	–	3
Retained fœtus, ...	1	–	–	–	1
Prolapsus uteri, ...	3	–	–	–	3
Metritis, ...	1	–	–	–	1
Emaciation, ...	4	11	11	–	26
Anæmia, ...	–	–	3	1	4
Pyæmic anæmia, ...	–	–	1	–	1
Weak condition, ...	1	53	–	–	54
Exhaustion, ...	1	–	–	–	1
Exposure, ...	–	2	–	–	2
Sexual odor, ...	–	–	2	–	2
Poisoning, ...	3	1	4	–	8
Lacerated, ...	–	–	9	–	9
Wounded, ...	–	–	–	6	6
Bruised, ...	1	31	2	–	33
Injured, ...	4	1	2	–	7
Internal injuries, ...	–	1	–	–	1
Strangulation, ...	4	–	–	–	4
Suffocation, ...	–	–	1	–	1
Improperly bled, ...	1	–	2	–	3
Stillborn, ...	–	5	–	–	5
Unstamped, ...	–	–	1	–	1
Illegally slaughtered, . . .	1	1	2	3	7
Died otherwise than by slaughter, .	3	4	2	–	9
Totals, ...	653	1,593	498	23	2,767

DIVISION OF COMMUNICABLE DISEASES.

DIVISION OF COMMUNICABLE DISEASES.

Report upon the Work of the Bacteriological Laboratory for the Year ended Nov. 30, 1916.

From Dec. 1, 1915, to Nov. 30, 1916, 22,140 specimens for examination have been received at the diagnostic laboratory of the State Department of Health. This number represents an increase of 25 per cent. over that of the year 1915, and an approximate increase of 85 per cent. in two years. The average number of specimens examined per day has been 60, and the cost per examination 26 cents. Table 1 shows the number, kind and results of examinations made during the year 1916.

Table 1.

	Results of Examinations.		
	Positive.	Negative.	Total.
Nose and throat cultures for diphtheria bacilli,	2,372	12,657	15,029
Sputum for tubercle bacilli,	773	2,347	3,120
Blood for typhoid (Widal test),[1]	442	1,628	2,144
Blood, urine and feces for typhoid bacilli (culture test),	36	291	327
Blood for malaria,	9	72	81
Smears for gonococci,	55	1,253	1,308
Miscellaneous (including spinal fluid for meningococci and tubercle bacilli, virulence tests for diphtheria bacilli and blood for paratyphoid).	–	–	131

[1] Atypical, 74.

In addition to performing the diagnostic work, the laboratory has made up and distributed 25,000 outfits to be used for the collections of specimens, and has sent to one State institution over 7,300 tubes of blood serum, to be used for private work.

The laboratory has also served as the distributing center for the biological products listed in the reports of the Biological Laboratory Division.

DIPHTHERIA EXAMINATIONS.

During the year 15,029 cultures have been examined for diphtheria bacilli. They are classified as follows: —

	Positive.	Negative.
Primary (for diagnosis),	1,400	9,549
Secondary (for release from quarantine),	972	3,108
Totals,	2,372	12,657

Approximately 6,000 of these cultures were taken in schools having a noticeable number of cases of diphtheria and in State institutions.

We have followed the custom adopted two years ago of examining all cultures for diagnosis three times, — first, a swab examination immediately upon receipt; second, after a short period of incubation; and third, after incubation over night. All cultures proving positive on the swab, or after a short period of incubation, are reported at once; the later examinations are made as a check. The percentage of positives that have been reported on the day of receipt is approximately 85. The majority of the positives not reported until the following day arrive at the laboratory in the late afternoon, and fail to show growth when the laboratory closes.

On account of this triplicate examination of cultures for diagnosis the number of smears made and examined for diphtheria bacilli was about 26,000.

EXAMINATIONS FOR TUBERCULOSIS.

There were 3,120 specimens of sputum examined for the presence of tubercle bacilli. This is an increase of 326 over the number examined last year. The percentage of positives was 24.7, which is about the same as last year.

Positive,	773
Negative,	2,347
Total,	3,120

TYPHOID FEVER.

Widal Test.

There were 2,144 specimens of blood examined for the Widal reaction for typhoid fever. The results are given in the following table, specimens showing a partial reaction being classified as atypical. This reaction is often shown during the first week of the disease.

Positive,	443
Negative,	1,628
Atypical,	73
Total,	2,144

Culture Test.

During the year 325 specimens from 176 individuals have been examined for the presence of typhoid bacilli. Of this number 36 were positive. The specimens were of blood feces, and urine from suspected cases, typhoid convalescents and suspected carriers. The distribution was as follows: —

Blood,	21
Urine,	69
Feces,	235
Persons sick,	55
Convalescent,	84
Suspected carriers,	37

Of the positives 3 were from sick persons, 23 from convalescents and 10 from carriers.

Eight carriers have been discovered during the year. Seven were engaged in the handling of food, four as milk dealers, one market gardener and two waitresses. Seven were fecal carriers and one urinary. The majority of these persons had typhoid fever several years ago, but two or three deny any knowledge of an attack of the disease.

In the laboratory the following technique is employed: the specimens are sent to the laboratory in peptone bile, or, more recently, in 30 per cent. glycerine in normal salt solution (as recommended by Clurman & Teague). Immediately upon receipt, the culture is streaked with a platinum loop upon a series of large plates poured with Endo's medium freshly mixed each day; more plates are used for feces specimens than blood or urine. At the end of from fourteen to twenty-four hours' incubation, colorless colonies are fished and inoculated into broth. After four to eight hours the broth cultures are examined for motile bacilli, and if these are found they are tested with a typhoid agglutinating serum. All showing agglutination are inoculated into sugar broth. Those cultures that are agglutinated by a known typhoid serum, and do not form gas in dextrose and lactose broths, are reported positive.

The substitution of the glycerine for the peptone bile is too recent for us to draw any conclusions as to the relative value of the two as yet. The claim is made that the bacilli survive longer in glycerine than in bile, but we have recently isolated the typhoid bacillus from a bile culture delayed four days in transit. One advantage of the glycerine that appears to us is that fewer colonies of the B. coli develop on the plates than when bile is used, and typhoid colonies are noticed more quickly.

MALARIA.

There were 81 specimens of blood examined for malarial parasites. This number is larger than that of any previous year, although the percentage of positives is still small.

Positive,	9
Negative,	72
Total,	81

EXAMINATIONS FOR GONORRHŒA.

This work has increased considerably during the year. It is regretted that very few smears are taken from the sore eyes of the new-born, so that we have no information regarding the prevalence of gonococci in cases of ophthalmia and conjunctivitis. The majority of the specimens sent to the laboratory are taken as a preventive measure by the State Board of Charity; 924 smears were examined for this Board. Results of all examinations are shown in the following table: —

Positive,	55
Negative,	1,253
Total,	1,308

MISCELLANEOUS EXAMINATIONS.

Miscellaneous examinations totaling 131 have been made. These included microscopic examination of spinal fluids for meningococci and tubercle bacilli, virulence tests of diphtheria bacilli, animal inoculation of urine sediments and spinal fluids suspected of containing tubercle bacilli, examination of specimens of blood for the Widal reaction for paratyphoid fever, and examination of feces for dysentery bacilli. In the course of the examinations of swabs for diphtheria bacilli, organisms of Vincent's Angina are observed and reported.

BACILLARY DYSENTERY IN HAVERHILL.

HISTORY.

From information received of two deaths of children in Chelsea, who had been at the New England Deaconess's Home in Haverhill, an investigation was made at this institution.

DESCRIPTION OF INSTITUTION.

The Home is situated on the road from Haverhill to Lowell, and consists of a large house, a barn, some tents and some cottages. It is in charge of a superintendent and a number of untrained workers.

The children, about 60 to 70 in number, are brought from various parts of Boston for periods of two weeks. They range in age from five to twelve years.

All of the inmates are fed from the central kitchen.

On July 19, a group of approximately 65 children arrived from Chelsea, East Boston, South Boston, Boston, Cambridge, Somerville, Dedham, Malden and Medford.

HISTORY OF OUTBREAK.

On Saturday, July 22, C. H. was taken ill with a temperature of 102, diarrhœa and considerable prostration. On Sunday the physician from Haverhill was called. He advised that the child be taken home. This was done on the following day. The child continued to have diarrhœa with bloody stools, but was up and around the house until Saturday. He became rapidly worse and died on Sunday.

On Monday, Tuesday and Wednesday a number of the children at the Home were taken ill with the same symptoms. Upon the advice of the attending physician, on July 27 the whole group of children were returned to their homes.

CASES.

While it was not possible to get complete reports of all of the cases, the following were obtained: —

Case No.	Name.	Onset.	Residence.	Termination.
1,	C. H.,	July 22,	Chelsea,	Death.
2,	M. W.,	July 23,	Chelsea,	Recovery.
3,	L. L.,	July 24,	East Dedham,	Recovery.
4,	M. M.,	July 24,	Chelsea,	Recovery.
5,	G. R.,	July 24,	East Boston,	Recovery.
6,	W. W.,	July 25,	Chelsea,	Death.
7,	F. W.,	July 24,	Chelsea,	Recovery.
8,	L. C.,	July 26,	Dedham,	Recovery.
9,	E. B.,	July 26,	Boston,	Recovery.
10,	J. B.,	July 30,	Chelsea,	Recovery.
11,	H. B.,	July 28,	Chelsea,	Recovery.
12,	H. M.,	July 28,	Malden,	Recovery.
13,	J. B.,	July 28,	Boston,	Recovery.

The State District Health Officer investigated the cases of illness among the children who returned from Haverhill. One of the number, W. W., died, and specimens for examinations were taken post mortem, but the dysentery bacillus was not isolated.

DETAILS OF INVESTIGATION.

The analysis of the data indicated that the infection pointed to either water, milk or food as the vehicle of transmission. The food supply was in charge of Miss B., matron. It was prepared in a central kitchen and distributed to every one at the institution. The diet of the Home was a general one, except that it contained very little meat and a high proportion of milk.

It was reasonable to exclude the food as a means of transmission by reason of the presence of cases outside of the Home who had not partaken of the general diet.

Water could also be excluded for the same reason plus the further evidence of the age distribution. At least 90 per cent. were in children all of whom were regular consumers of milk, while if water were the vehicle of infection, the age distribution would have been greater in the higher age group.

MILK SUPPLY.

The milk supply of the Home was purchased from dealer A. A. T. This dealer purchased practically the whole of his supply from the R. farm. The conditions under which the milk was handled at the dealer's farm were far from satisfactory, both from the standpoint of sanitary conditions and the facilities for cleansing utensils. Five cans of milk were obtained from the R. farm in the original cans, and did not go to the T. farm at all. The cans were taken to A. A. T.'s for washing.

The R. farm is a well-conducted dairy and truck farm. The sanitary arrangements are good. There are two large barns. The milk house is a good one.

Food and Milk Handlers.

Miss B., the matron in charge of the cooking, gives a history of chronic diarrhœa every summer. Blood sample and sample of bowel contents were taken and sent to the laboratory, but proved negative for typhoid and for dysentery.

H. P., Sr., in charge of barn No. 1 at the R. farm, gave a history of illness in his family before the outbreak at the Deaconess's Home. His child, H. P., Jr., was taken ill with acute enteritis on July 16, following a visit to Lawrence, where he had eaten ice cream. The child was taken ill July 16 and died at the Gale Hospital on July 19.

T. P., second child in the family, was also ill with enteritis.

The mother was ill with same symptoms.

The father, who had diarrhœa, continued to milk during the entire course of his sickness.

At the same time G. R., A. R. and D. R., members of the R. household, were also ill with diarrhœa on July 30.

The history of the rest of the workers on the farm was negative.

Water Supply.

At the R. farm the supply is a combination of Methuen town and farm spring water. Springs accessible to temporary help (mostly foreigners) on the place. Never been analyzed.

At the Deaconess's Home a private reservoir is situated on the hills back of the Home. Inspection showed it well isolated in the woods, but in a favorable position to be polluted by surface wash from above if any of the neighboring foreigners should use the woods for a privy.

A report from the Engineering Division on the water showed no serious pollution.

Analysis of the Data.

The occurrence of approximately 20 cases of enteritis of a possible exposed group of 75 persons points to either water, milk or food as a vehicle of transmission.

Food may be excluded by the occurrence of cases outside of the Home who had not partaken of the common diet.

Water may also be excluded for the same reason plus the further evidence of the age distribution.

PRIMARY CASE.[1]

While it was not possible, on account of the lateness of our original information, to make cultural examination of the cases at the R. farm, the illness occurred before the onset of the cases at the Home. The father and other members of the household were affected, while the father continued to handle only a portion of the milk that went into the supply of the Deaconess's Home. The ice cream that the P. child ate in Lawrence was investigated. The firm that furnished the ice cream pasteurizes all of their milk and cream. There was no history of any illness among the employees of this farm.

SECONDARY OUTBREAK.

Positive Cases.

Through the courtesy of Dr. Wilson G. Smillie we were enabled to trace a secondary outbreak of this infection to Dedham. L. C., one of the children who returned from Haverhill to her home in Dedham, was nursed by her mother and neighbors. The excretions were thrown into an open privy without disinfection. She was taken to the Lynn Hospital.

Case 1.—W. C., brother of Case 8 of the primary series, age thirteen, became ill August 3 and was taken to the Peter Bent Brigham Hospital.

Case 2. — D. C., sister of Case 8, taken sick August 5 was sent to the Children's Hospital.

Case 3. — H. C., another sister of Case 8, age four and a half, was taken sick August 6 and removed to the Children's Hospital.

All of these children were very ill, but finally recovered. In all of the cases, either by agglutination test or isolation from the stools, bacillus of dysentery (Shiga) was demonstrated.

Case 4. — L. E., nineteen months old, living opposite to the above cases, was taken sick August 10 and died August 13. Diagnosis made upon clinical examination.

Case 5. — R. J., two years and three months, living next door to the above cases, became sick August 19, and was taken to the Floating Hospital and died. Diagnosis confirmed bacteriologically.

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[1] Complete records not obtainable.

Suspected Cases.

Four-months old baby, in the same family with Case 4 of the secondary series, was taken sick August 21 with diarrhœa and prostration. Diagnosis not confirmed bacteriologically.

Four adults in the house four doors from the C. family were taken with similar clinical symptoms and fever. A physician was not in attendance.

Blood specimens for agglutination test could not be obtained.

Another adult, whose wife assisted in nursing the C. child, was ill with the same symptoms.

CONCLUSIONS.

This group of bacillary dysentery cases was, in all probability, transmitted through the medium of the milk supply. The secondary group of cases was undoubtedly due either to direct contact or fly transmission.

HUMAN ANTHRAX.

INTRODUCTION.

The unusual incidence of anthrax reported to this Department began the early part of March and called for special investigation. The reports came principally from the towns of Winchester and Woburn. A study of these reports revealed the fact that practically all of the cases were occurring in tannery workers. Closer investigation showed that these individuals were handlers of dried hides.

The completed investigation of this subject has demonstrated the potential danger of dried, imported hides. It has shown the importance of better data concerning the anthrax-infected areas, particularly in China, India and Africa. A study of the subject has further shown the necessity for the discovery of a more satisfactory method for the disinfection of hides and for definite attention to occupational hygiene in the tanning industry. In fact, the importance of the hide and leather industry in this Commonwealth justifies a complete and careful study of this subject, both from the economic and public health standpoint.

HISTORY.

Anthrax is the most ancient infectious disease of animals that is known. Moses, in his second book, mentions it and calls it the "sixth plague of Egypt;" in his third book he indicates the transmission of anthrax to man by means of soiled clothing. The epizoötic disease, described by Homer in the first book of the "Iliad," and which affected men, mules and dogs, was probably no other than anthrax. In the ninth book of his "Metamorphoses" Ovid gives an exact description of anthrax epizoötics. Plutarch has given the history of an epizoötic of anthrax which existed in Rome about the year 740 before our era. Dionysius of Halicarnassus (488 B.C.) and Livius (425 B.C.) have mentioned examples of anthrax affections which existed first in animals living upon pastures, then in such as were kept in stables, in animals destined for sacrifices, in priests, shepherds, farmers, and lastly upon the whole population. Lucretia (428 B.C.) designated anthrax by the term "*ignis sacer;*" Columella has given to it the name of "malignant pustule." Virgil has described a disease of the sheep which was transmitted to man by the contact of furs, wool and cadavers, and produced in the integument ulcerating lesions which extended to the muscles. Pliny speaks of a carbuncular affection which existed in Gaul (old France) in the neighborhood of Narbonne. The Arabian physicians knew anthrax under the name of "Persian fire." Mézeray (A.D. 966) called it "St. Anthony's fire." In Italy John Wierus has mentioned several epizoötics of it in the second half of the sixteenth century (1552, 1598, 1599). In 1617 Athanasius Kirchner gave the description of a disease of the bovine species which was transmissible to man and which killed 60,000 people. In 1662 anthrax became much extended in the neighborhood of Lyons. In 1850 Heussinger published a work upon anthrax which was remarkable from an historical and a geographical standpoint. He considered it as a "malarial neurosis."

In 1855 Pollender announced that he had found in the blood of bovines infected by anthrax a considerable quantity of "fine little sticks." These were also seen by Davaine (Paris) in 1850 and by Branell (Dorpat) in 1857. It was in 1863 that Davaine recognized these elements as bacteria, and gave them their present name, — Bacillus anthracis. In 1876 Koch proved the pathogenicity of these organisms. The classical work of Pasteur on anthrax is familiar to all medical men. During the latter part of the same century the English government made an extensive study of pulmonary anthrax, or "wool sorters' disease."

The earliest accounts of human anthrax in Massachusetts were furnished by Pierson of Salem and Silas E. Stone of Walpole. Pierson, writing in the "Boston Medical and Surgical Journal" in 1852, says: "During the last thirty years I have been in the habit of seeing this affection every few years. It occurs among workers of green hides, — as curriers and tanners, — and among 'lumpers,' or men employed in unloading vessels laden with hides. It is imputed to the bite of a centipede or some other insect of South America." He reports six cases. His treatment consisted of stimulation internally and the local application of silver nitrate and "lead water and laudanum." Stone reported to the Massachusetts Medical Society a series of twenty-six cases occurring in a Walpole hair factory from 1853 to 1870. The details of these cases are included in a comprehensive report on "Charbon in Massachusetts," by Arthur H. Nichols, and published in the annual report of the Massachusetts State Board of Health for 1871.

During the period from 1865 to 1906 the registration reports of

Massachusetts record 128 deaths from anthrax. The detailed records of most of these cases cannot be obtained.

Anthrax was made a reportable disease in Massachusetts in August, 1907. Since that time 64 cases have been reported, with 20 deaths.

Year.	Cases.	Deaths.	Fatality (Per Cent.).
1865-1906,	-	128	-
1907,	1	4	-
1908,	5	2	40.0
1909,	7	1	14.3
1910,	7	2	28.6
1911,	6	2	33.3
1912,	11	2	18.2
1913,	8	3	37.5
1914,	8	1	12.5
1915,	11	3	23.1
Totals,	64	20	31.2

This fatality rate is considerably above the average experiences, both in England and Germany. The detailed data on these cases had not been recorded. They were distributed in cities and towns, as follows: Lynn, 17; Boston, 12; Peabody, 6; Haverhill, 6; Woburn, 3; Norwood, 3; Methuen, 3; Worcester, 2; Dedham, 1; Chelsea, 1; Brockton, 1; Fall River, 1; Springfield, 1; Wakefield, 1; Winchester 1; Cambridge, 2; Sheffield, 1; Salem, 1; and Revere, 1.

Description of Disease.

A brief description of the clinical features of anthrax will make its sources and modes of transmission much clearer. It is known under a variety of titles, some of which are wool sorters' disease (pulmonary form), malignant pustule (external form), charbon and Milzbrand.

Anthrax is essentially a disease of animals. It is found in practically every country in the world. At the present time cattle and sheep are the chief sufferers. Herbivorous animals are particularly susceptible. There have been numerous epizoötics among animals, causing enormous economic losses.

Anthrax in man is derived from some domestic animal or commerical animal product, especially hides, hair or wool. The bacillus does not penetrate the unbroken skin, but enters some abrasion, scratch or cut. It occurs particularly among veterinarians, brush makers, leather workers, tanners and farmers. Human anthrax is particularly prevalent in Italy, in which country 36,426 cases have been reported in fifteen years. Internal anthrax is common in England, where wool and hair are handled. The comparative danger from the various materials is illustrated by the English statistics from 1899 to 1907, during which time 447 cases, with 120 deaths, from all forms of anthrax were reported.

WORKERS IN —	Cases.	Deaths.	Mortality (Per Cent.).
Worsted and wool,	175	47	26.8
Horsehair and bristles,	104	26	25.4
Hides and skins,	131	34	26.6
Other industries,	37	13	37.0
Totals,	447	120	26.8

Gastrointestinal anthrax may result from the eating of flesh of animals infected with the disease.

BACTERIOLOGY.

The habits and characteristics of the bacillus of anthrax are of interest. It is one of the largest pathogenic bacteria. It stains readily with the usual basic aniline dyes, and is not decolorized by Gram's method.

The bacillus grows best at 35° C., and ceases to grow below 12° C. or above 45° C. It owes much of its pathogenic power to its property of forming spores. This takes place best at 32° C., and the presence of oxygen is necessary. These spores are remarkable for their power of resistance to external agencies, and, when dry, retain their vitality and virulence indefinitely.

Moist heat of 70° C. kills the bacilli in one minute, but the spores must be subjected to live steam or boiling for more than five minutes, and to dry heat of 140° C. for at least three hours, to insure their destruction. Cold has no effect on them. They resist 5 per cent. carbolic acid for two or more days, while corrosive sublimate (1 to 1,000) often fails to kill them in two hours. Unlike the vegetative organism, they are unharmed by the gastric and intestinal secretions. The ordinary processes of tanning leather do not affect the spores injuriously. Ravanel has kept them immersed for two hundred and forty-four days in the strongest tanning fluids without any perceptible change in their vitality or virulence.

Forms of Anthrax.

There are two forms of anthrax, external and internal.

External anthrax is the most common form in man, and is the result of direct inoculation. It occurs almost always on those portions of the body which are habitually uncovered, such as the face, neck and arms. The lesion is usually single, although two and even three points of inoculation have been observed. The period of incubation is from one to three days.

At the point of inoculation a small red papule appears, always accompanied by itching and burning. On the second day a flattened vesicle has formed, which may be surrounded by some redness and swelling. The vesicle soon ruptures, and is replaced by a yellowish erosion, which rapidly becomes brown, and, by the fourth day, a black, depressed eschar has formed. This is surrounded by a very characteristic border of small vesicles. Surrounding tissues are the seat of a hard œdematous swelling, and neighboring lymphatics are often involved.

The freedom from pain in and about the lesions is remarkable. Pus is never formed until the eschar begins to separate. The general symptoms are very variable, and bear no relation to the extent of the local lesion. The early symptoms are lassitude, malaise and headache. Fever may be absent and is usually not marked. The temperature is not an index to the gravity of the infection.

There are two forms of *internal anthrax,* — intestinal and pulmonary. Intestinal anthrax is rare in man but a usual one in cattle. The onset is sudden. Gastrointestinal symptoms are the most prominent. They are marked by unusual, persistent vomiting and diarrhœa, with marked abdominal pain. The temperature is usually only slightly above normal. Death may take place in thirty-six to forty-eight hours. The usual duration is five to six days.

In the pulmonary form of anthrax (wool sorters' disease) the symptoms may be vague and slight until just before death. The patient may seem only slightly ill, when suddenly he goes into collapse, becomes cold, pulseless, and dies within a few hours. The lungs are always involved. Cough is generally present. The sputum is seldom abundant and may contain blood or be rusty. Anthrax bacilli are sometimes found in it. The temperature is seldom high. Death takes place, in the majority of cases, on the second, third or fourth day.

Description of Outbreak.

During the period from Feb. 17, 1916, to June 27, 1916, there were 25 cases of human anthrax reported to the State Department of Health. This constitutes the severest outbreak of this disease ever recorded in Massachusetts. A clinical and epidemiological study of these cases has revealed some interesting facts as to the sources and modes of infection, methods of prevention and treatment of this disease.

Epidemiology.

While 23 of the 25 reported cases were in persons handling hides, the most interesting group consists of 20 cases which were infected from a common source. An analysis of the early reports showed that the infection was confined to the workers in three tanneries located in Winchester and Woburn. Further study revealed the fact that every one of the persons infected had been handling dried "China" hides.

To find a common source of hide supply for three rival tanneries seemed hopeless. This problem was solved by the co-operation of the State District Health Officers, Dr. Charles E. Simpson and Dr. Stanley H. Osborn. The key to the situation was discovered in the characteristic trade-mark stamped upon the hides. While all three of the tanneries received hides through Boston and New York brokers, the brokers in turn purchased them through a common agent in New York City. By means of this characteristic trade-mark, the particular lots of hides involved were traced through the Boston and New York brokers to two cargoes of hides which entered the United States at the port of New York from Hankau, China.

A representative of the Department visited New York and traced through the brokers and Custom House all of the hides arriving on the same ship with the suspected hides coming to Massachusetts. It was found that the portion of China from which these hides originated is an endemic focus of anthrax. From these cargoes of hides each one of the tanneries involved received a considerable shipment. Further, the shipping receipts for the hides showed that they arrived at the tanneries before the first case of anthrax.

The next step was to demonstrate the exposure of the infected men to these hides. A comparison of the time when the hides were in the process of being tanned with the working time of the infected men furnished the test. Every one of the men handled the hides bearing the characteristic trade-mark. This completed the picture. Hides coming from the infected territory, shipped to the tanneries involved, handled by men who came down with anthrax, with no cases in other tanneries, is sufficient evidence upon which to convict this shipment of hides of being the cause of this particular outbreak of anthrax.

Clinical Histories.

The interesting clinical features of this group of cases may be conveniently condensed into the following table: —

No.	Date.	City or Town.	Occupation.	Location of Lesions.	Treatment.	Result.
1,	1916. Feb. 17,	Worcester,	Wool sorter,	Left side of neck,	Serum (commercial),	Recovery.
2,	Feb. 23,	Peabody,	Truckman,	Right temple,	Excision. Bichlorid dressing.	Recovery.
3,	Mar. 2,	Winchester,	Tannery worker (beam house).	Left side of neck,	Excision,	Death.
4,	Mar. 9,	Woburn,	Tannery worker (beam house).	Forehead,	Antiseptic compresses,	Recovery.
5,	Mar. 13,	Woburn,	Tannery worker (beam house).	Forehead,	Cauterized. Moist bichlorid dressing.	Recovery.
6,	Mar. 14,	Chelsea,	Dock laborer,	Left side of neck,	Bichlorid dressing,	Death.
7,	Mar. 14,	Winchester,	Tannery worker (beam house).	Right side of neck and right thigh.	Excision under ether,	Recovery.
8,	Mar. 16,	Woburn,	Tannery worker (beam house).	Left side of neck,	Antiseptic compresses. Bichlorid dressing.	Recovery.
9,	Mar. 18,	Winchester,	Tannery worker (beam house).	Right forearm,	Compress, 70 per cent. alcohol.	Recovery.
10,	Mar. 21,	Woburn,	Tannery worker (beam house).	Left cheek,	Boric dressing,	Recovery.
11,	Mar. 21,	Winchester,	Tannery worker (hide splitter).	Left side of neck,	Bichlorid dressing,	Recovery.
12,	Mar. 21,	Winchester,	Tannery worker (die stamper).	Left side of neck,	Bichlorid dressing,	Recovery.
13,	Mar. 27,	Somerville,	Hide weigher,	Left side of neck,	Excision. Bichlorid dressing.	Recovery.
14,	Apr. 10,	Woburn,	Teamster,	Left side of neck,	Antiseptic bichlorid dressing.	Recovery.
15,	Apr. 11,	Winchester,	Tannery worker (beam house).	Right side of neck,	Bichlorid dressing,	Recovery.
16,	Apr. 20,	Boston,	Teamster,	Right side of neck,	Excision,	Death.
17,	Apr. 20,	Clinton,	Farmhand,	Left hand,[1]	Carbolic dressing,	Recovery.
18,	May 1,	Woburn,	Tannery worker (beam house).	Left side of neck,	Bichlorid dressing,	Recovery.
19,	May 1,	Woburn,	Tanner,	Left cheek,	Bichlorid dressing,	Recovery.

20,	May 2,	Woburn,	Tannery worker (beam house).	Left ear,	Bichlorid dressing,	Recovery.
21,	June 3,	Woburn,	Tannery worker (flesher),	Right side of neck,	Corrosive dressing,	Death.
22,	June 4,	Winchester,	Tannery worker (beam house).	Left side of neck,	Corrosive dressing. Serum 45 c.c. and 20 c.c.	Recovery.
23,	June 16,	Norwood,	Tannery worker (beam house).	Right arm,	Refused treatment,	Recovery as far as known.
24,	June 23,	Woburn,	Tannery worker,	Left side of neck,	Antiseptic dressing,	Recovery.
25,	June 27,	Woburn,	Tannery worker (beam house).	Right groin,	Dry, sterile dressing,	Recovery.

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[1] Abrasion of hand received while helping to bury a cow dead from anthrax.

TREATMENT.

The record of the treatment of this group of anthrax cases is of interest. The variety of methods used, all of them more or less unsatisfactory, is striking.

As a result of correspondence with the Bureau of Animal Industry of the United States Department of Agriculture, and through the kindness of Dr. Adolph Eichhorn, chief of the Pathological Division, who has perfected the treatment of anthrax in animals, information was obtained of the application in man of anti-anthrax serum.

Dr. Eichhorn says: —

> Extensive data are available on the effectiveness of anthrax serum for the treatment of the disease in man. It is recommended that from 30 to 40 cubic centimeters of serum be injected in three or four different places. Should no improvement follow in twenty-four hours an additional injection of 20 to 30 cubic centimeters of serum should be administered. In most instances the results are very favorable, and this treatment is acknowledged to be superior to any other mode of treatment known for this disease.

While the number of cases to which this treatment has been applied is small, it seems to offer the most rational method of treatment at the present time. Since most of the cases in this community were treated at the Massachusetts General Hospital, we arranged to have a supply of the serum on hand at that hospital. The State District Health Officers were informed by circular letter of our ability to get the serum by telegraphing Washington, and the same information will be forwarded to all of the hospitals that are likely to need it.

PREVENTION.

The important fact brought out by this investigation was the necessity for devising some adequate means of controlling this infection. The evidence obtained showed that practically all of the infection in this group of cases resulted from infected hides imported from China. However, studies made in this and other parts of the United States indicate that the same thing is true of hides coming from India, South Africa and South America.

The problem then can be attacked as follows: —

(*a*) Prevention of the importation of infected hides.
(*b*) Disinfection of hides.
(*c*) The safeguarding of the workmen.
(*d*) Proper disposal of wastes from tanneries.

The regulations under which hides are imported from foreign countries into the United States are covered by Treasury Department Circular of May 2, 1910, the essentials of which are as follows: —

> Abattoir hides, the product of Sweden, Norway, New Zealand, Australia, Great Britain and Argentina, may be imported without disinfection when accompanied by a certificate of an official veterinarian of the country where slaughtered, showing that the same were taken from cattle free from disease at the time of slaughter.
>
> All other hides of neat cattle, including calf skins, from any part of the world except North America must either be accompanied by a certificate signed by the American consul of the district from whence shipped, stating that anthrax is not prevalent and that neither foot-and-mouth disease nor rinderpest exists in such district, or they must be accompanied by a certificate signed by the American consul showing disinfection by immersion for thirty minutes in a 1 to 1,000 bichlorid of mercury solution.
>
> If certified by the American consul as coming from a district in which anthrax is not prevalent, a certificate of disinfection by immersion in a 5 per cent. solution of carbolic acid will be accepted. In the case, however, of hides from districts in which anthrax is prevalent, disinfection by immersion for at least thirty minutes in a 1 to 1,000 bichlorid of mercury only will be permitted.
>
> Fleshings, hide cuttings and parings or glue stock may be imported without disinfection when the same is shown by consular certificate or by the consular invoice used upon entry to have been lime-dried after soaking for forty days in a strong lime wash, or to consist of glue stock which has been dried by exposure to the action of the sun and air for sufficient time to render each piece of the hardness of a sun-dried hide, provided a certificate in proper form is filed with the American consul by the exporter showing that none of the products shipped were taken from animals affected with anthrax.

It will be noted that there is an alternative in the compliance with these regulations for the admission of hides to this country. First, they may be accompanied by a certificate signed by the American consul of the district stating that anthrax is not prevalent in such district, or they may be accompanied by a certificate signed by the American consul showing that they have been disinfected by immersion for thirty minutes in a 1 to 1,000 bichlorid of mercury solution.

At the present time we do not know how general the admission of hides is under this provision. We have been unable to obtain from the Bureau of Animal Industry, or the Department of Commerce, or the Department of State, any definite knowledge as to the distribution of anthrax infection in any of the hide-producing countries. In fact, the Department of Commerce referred us to the Consul General of Great Britain in New York and the Chinese Consul, also in that city, for information. Correspondence with these representatives was unproductive of any useful information. It can therefore be concluded that there are no reliable data on the distribution of anthrax in foreign countries. Consequently, the admission of hides to this country on certificates under the first provision of the regulation would seem to be a doubtful procedure.

The second method by which it is attempted to control the spread of anthrax infection is by means of the disinfection of hides. The treasury regulations quoted above require disinfection by immersion for at least thirty minutes in a 1 to 1,000 bichlorid of mercury solution. Dr. F. W. Tilley, bacteriologist of the Bureau of Animal Industry, has shown that it does not kill the anthrax spores. The method now recommended was devised by Professor Schattenfroh, and consists of an immersion in a 2 per cent. hydrochloric acid gas and 10 per cent. sodium chlorid solution for forty-eight hours. It is maintained that this seriously interferes with the tanning process, injures the hides and is quite expensive. The Surgeon-General of the United States Public Health Service has recommended the use of a 2½ per cent. formalin solution and a 1 to 1,000 bichlorid of mercury solution.

In .the seventeenth annual report of the Wisconsin Agricultural Experiment Station, 1889, is given an account of the "Action of Formaldehyde on Hides," which demonstrates that it also seriously interferes with the tanning process.

We are forced to conclude that at the present time there is no satisfactory and efficient disinfectant that will kill the anthrax spores and not injure the hides for commercial purposes. It would seem that this is a fertile field for research in order to discover some satisfactory method of disinfection.

At the request of the Commissioner of Health, Mr. H. W. Clark, director and chemist of the Division of Water and Sewage Laboratories, has submitted a very thorough study in regard to tanneries and glue works and their wastes in connection with anthrax. He points out that there are three main classes of wastes from tanneries, as follows: —

1. Grease pressed from the hides used in dressing leather, etc.

2. Solid wastes scraped and trimmed from hides sold to glue and gelatine factories.

3. Liquid wastes, containing much solid material, both that washed and scraped from the hides and chemicals and other materials used in the various tanning processes.

These liquid wastes, containing much solid matter, generally flow to settling or sedimentation tanks for the removal of a considerable percentage of the solid matter in suspension, and the liquid portion then passes into sewers or water courses. In some instances, however, the liquid waste is treated upon filters.

According to the report of the Metropolitan Water and Sewerage Board for the year 1914, the valueless solid waste settled out in tanks at the tanneries and glue works in Winchester, Woburn and Stoneham amounted in that year to nearly 6,000 cubic feet. These solid wastes are first disposed of generally upon sludge beds in the tannery yards, and are occasionally used for filling in low places. Considerable of this sludge when sufficiently dried is carted to dumps in more or less settled portions of the town. Hardly any is used by farmers at the present time. The liquid wastes from the tanneries and glue works in Winchester, Woburn and Stoneham pass into the north metropolitan sewer, and hence to the Deer Island outlet of this sewer into Boston Harbor.

The solid trimmings and scrapings from the hides, which are used in glue and gelatine works, are handled by the employees in these works. From some of the tanneries these wastes are shipped in box cars, and from others the wastes are carted to neighboring glue works.

The stock used in making gelatine consists of horn trimmings, fleshings, trimmings of calfskins, etc. The glue stock consists of the trimmings from cowhides and horn trimmings.

One of the early steps in the processes of the manufacturing of glue and gelatine is the subjection of the material to a temperature of from 20 to 30 pounds' steam pressure, equal to 600° F. or 700° F. There have been no cases of anthrax reported from these works.

The liquid and solid wastes from the tanneries are high in bacterial content. Anthrax spores have been demonstrated in the fresh sludge from the tannery vats. Infection in cattle has been shown to have been caused by anthrax-infected liquid wastes polluting meadows where cattle are fed. The only records of infection due to sludge from tanneries have been recorded in England.

Mr. Clark suggests that experiments might be undertaken by drying hides coming from infected districts with steam under pressure. It would seem that there is a fertile field for research in order to discover some satisfactory method of disinfection, and this method is surely worthy of a careful trial.

In view of the fact that it is impossible to exclude infected hides from this country, and that there is no satisfactory method of disinfection, the safeguarding of the workers in hides becomes the most important single factor for consideration.

The sanitation of the tannery itself should receive careful attention. It has been customary to think of the tannery as a place that did not lend itself to cleanliness. Consequently, little effort has been made to bring the working conditions in this occupation up to the standards of other manufacturing establishments.

The character and methods of transmission of anthrax make it possible for the machinery, utensils and vats to become highly infected with this organism. While so far as is known no human cases of anthrax have been traced directly to infection through the medium of machinery, utensils and vats, it must be an ever-present possible source of infection. Therefore especial attention should be paid to the careful cleansing and disinfection of all machinery, utensils, vats, etc., used in the tanning industry, especially in the earlier processes of tanning.

The personal hygiene of the worker is of great importance. The infection of anthrax practically always takes place on the exposed portions of the body through a cut, scratch or abrasion in the skin. Consequently, the logical method of prevention should be the use of gloves and proper clothing so as not to expose the body unnecessarily to inoculation with the infection. It would seem, therefore, that the insistence upon cleanliness of the workmen, and frequent washing and disinfection of the clothing used in the occupation, would be one of the most important steps for the protection of the workmen.

Proper disposal of the wastes from tanneries is a subject of considerable importance. After a careful study of this aspect of the question, very few instances have been found of cases of anthrax being communicated to man by means of tannery wastes. It is, however, an important mode of infection in cattle. Through this avenue the disease is communicated in the United States, and if not properly controlled will tend to result eventually in large numbers of anthrax-infected hides in this country.

CONCLUSIONS.

First. — This outbreak of anthrax illustrates the potential danger of this infection as an important public health problem.

Second. — The accumulated evidence shows that practically all cases of anthrax occurring in the United States are due to the importation of infected material, principally dried hides.

Third. — The regulations governing the importation of hides issued by the United States government failed to exclude anthrax infection. This is due to a lack of reliable data as to the distribution of anthrax among cattle in the hide-producing countries, and to the unreliable methods of disinfection of hides.

Fourth. — Insufficient attention is paid to the sanitation of tanneries and to the safeguarding of the workers.

Fifth. — Waste products from the tanneries may be a source of human infection and act as a source of infection among American cattle.

Sixth. — The serum treatment of anthrax is worthy of a careful trial.

RECOMMENDATIONS.

First. — That a discussion be held with the Federal authorities relative to the better control of the importation of anthrax-infected hides. This control might, perhaps, be more efficient if exercised through the United States Public Health Service rather than Treasury Department regulations and certificates from the United States consuls.

Second. — That experiments be carried out to find a satisfactory, practicable and reliable method for the disinfection of hides. The suggestion of Mr. Clark that experiments be undertaken for the treatment of infected hides with steam under pressure is worthy of careful trial.

Third. — That a circular be issued to officials of the hide and leather industry, giving them the results of this investigation.

Fourth. — That a circular be issued to the hospitals, advising them of the serum treatment and of its availability through the United States Bureau of Animal Industry.

ANTHRAX INFECTION AMONG TANNERY WORKERS.

A careful study of anthrax infection among tannery workers has directed the attention of this Department to the importance of this subject to the hide and leather industry.

It seemed desirable that the information accumulated during the course of this investigation should be placed in the hands of those to whom it would be of the most service. Accordingly, we are outlining below the essential points about the origin, modes of transmission and methods of prevention of anthrax infection.

Origin.

Practically all cases of anthrax in this country are due to the importation of infected material, particularly dried hides. While a large percentage of the infection has been shown to have come through dried "China" hides, there are also records of cases due to hides coming from India, South Africa and South America.

Modes of Transmission.

The most usual modes of transmission of this infection to tannery workers are as follows: —

First. — Infection from the handling of the dried hides before the beginning of the tanning process. In this class comes the longshoreman, teamster and the laborer at the tanneries.

Second. — Infection through the processes of tanning. The records of the cases at hand show that infection occurs only in the early processes of tanning, particularly in the beam house. Infection but very rarely occurs beyond this step in the tanning process.

Third. — Infection from wastes and by-products. Careful bacteriological study, both in this country and abroad, has shown that anthrax spores will survive the tanning process. While the records of investigations show but a very few cases of infection caused by these wastes, yet they are always a source of danger.

Methods of Prevention.

The possible methods of prevention of anthrax infection may be summarized under the following heads: —

First. — Prohibiting the importation of hides from infected regions.

Second. — Disinfection of hides imported from infected regions.

Third. — Disinfection of machinery and appliances.

Fourth. — Protection of the workers.

The prohibition of the importation of infected hides would be the logical method of prevention. The absolute necessity for securing a sufficient supply of hides makes it impossible to attempt any wholesale exclusion of these materials. The lack of reliable information on the part of the Federal authorities as to the infected areas in hide-producing countries makes it unreasonable to attempt to place an embargo on hides from a given region.

Anthrax infection might be prevented by the disinfection of hides. Careful study of the methods of disinfection of hides has shown that at the present time there is no satisfactory, reliable and feasible method of efficiently disinfecting hides. Further experiments, both by governmental and private agencies, should be conducted to discover a satisfactory method of disinfection that would not injure the hides for commercial purposes.

The vats, utensils and appliances used in the early processes of tanning should be given especial care. The great vitality of the anthrax spore makes it important that an effort should be made to disinfect these vats, utensils and appliances.

Workers could and should be protected somewhat more than at the present time. Steps that could be carried out in this respect are —

(*a*) Issuing a plain simple warning to the workers as to the dangers of anthrax infection, mode of infection, and post precautions for the individual worker to take to avoid such infection.

(*b*) Insisting upon the wearing of rubber gloves by the workers in the most dangerous processes, and having them wear clothes of such character that they could be easily sterilized by boiling, — and to have such sterilization carried out frequently, — and by attention to the cleanliness of hands when off duty.

(*c*) By closer medical supervision. This should take the form of frequent inspection of the workers engaged in the earlier processes of the tanning, when special attention should be given to small abrasions, cuts, scratches and pimples, and to the temporary exclusion of any worker from these processes who exhibits such possible points of entrance for the anthrax germ.

TYPHOID FEVER AT LYNN.

HISTORY.

Beginning Aug. 25, 1916, 114 cases of typhoid fever were reported to the Lynn board of health. The early analysis of the reports indicated that the cases were located entirely in West Lynn and confined to the route of a single milk supply.

EPIDEMIOLOGICAL INVESTIGATION.

The epidemiological investigation was conducted by State District Health Officer Dr. A. A. Brown and the epidemiologist. The early investigation of the epidemic indicated that the mode of transmission was either milk or water. The increasing number of cases on a single milk route led to a tentative diagnosis of a milk epidemic.

ONSET OF CASES.

The compilation of cases, taken from the day of onset rather than the date of report to the board of health, showed an explosive onset of cases which had its crest on the 21st and 22d of August. The onset of the last primary case was on September 8.

AGE INCIDENCE.

The analysis of age incidence is not typical of a milk outbreak of typhoid fever.

Under 5,	12
5– 9,	12
10–19,	25
19–29,	28
30–39,	11
40–49,	12
Total,	100

Milk Supply.

The milk distributor under suspicion was located at the K. farm in Melrose. His supply was made up from three sources. He produced 1,500 quarts daily on his own farm, and about 150 quarts were purchased from the S. P. farm in Saugus, and an irregular amount was purchased through contractor F. of Melrose, who in turn received his milk from various points in New Hampshire.

Inspection of the K. Farm. — The general sanitary conditions of the farm were found to be fair, with the exception of an open privy in the barnyard 150 feet from the milk house.

Milk House. — All of the milk entering this supply is handled at the K. farm in a separate house. The facilities for the proper bottling, capping and distribution are excellent. There are ample provisions for sterilization of all the utensils by live steam. Two men are employed constantly in caring for the milk bottles and utensils. There is a large ice box for the storage of milk. The only criticism that could be made was the presence of a large number of flies.

Cow Barn. — The sanitary conditions in the cow barn were excellent. The stalls were clean, the walls whitewashed, ventilation adequate and the disposal of manure was above the average.

Water Supply.

The water supply at the farm is taken from two sources. The water for the house is secured from the city of Melrose, and the water for the barn and milk house is taken from a dug well about 300 yards from the milk house. This well is covered by a wooden cover, and is not well protected on the side. It is located in a cornfield, and within 15 feet of the overflow from Long Pond. The examination of this water supply by the Engineering Division has shown evidences of pollution. A survey of the brook which drains Long Pond did not reveal any evidence of any human pollution or possible connection with typhoid fever cases.

Clinical Examination of Milk Handlers.

A careful survey has been made of all the individuals that had to do with the handling of the milk that made up the supply from the K. farm.

K. Farm. — The only history of typhoid fever among any of the employees of the K. farm was in milker F. D. This man gave a history of having had typhoid fever two years ago, and had come to the K. farm after the onset of typhoid fever. His Widal, stool and urine were all negative.

Widal examinations were made of all persons and employees on the K. farm. In only one case, that of Mrs. S., was there either a suggestion or a positive reaction. Two unsatisfactory specimens of feces and urine resulted negatively. There was some difficulty in persuading this individual to give us a series of specimens. She denies any history of typhoid fever.

S. P. Farm. — At this farm Wida's were taken from all persons. In one case, F. F., age seventy-four, who had been an inmate of this farm for over thirty years, gave a positive Widal reaction. He is very feeble and had nothing to do with the handling of milk or utensils. Urine and feces were both negative.

New Hampshire Milk Supply. — The dealer in Melrose who temporarily supplies the K. farm received this milk from the B. farm in Derry, N. H. In company with the inspector of the New Hampshire State Board of Health the epidemiologist made a survey of this farm.

Mr. B. buys no milk. He has a very airy, clean, well cared for farm with a separate milk house. This milk house is somewhat old, but is well cared for. The water supply is taken from a driven well about 100 feet in the rear of the barn. A sample examined by the State Laboratory of New Hampshire proved that the water showed no evidence of pollution. There have been no reported cases of typhoid fever in Derry or Londonderry, N. H., within the last six months.

Employees of Farm. — None of the milk handlers gave a history of typhoid fever. Widals were taken from all persons who had to do with the handling of the milk. The results were all negative, and this was confirmed by the reports received from the New Hampshire State Board of Health.

Analysis of Data. — The analysis of the data of this investigation has not enabled us to make a positive diagnosis of the primary source of the infection. The temporary supply received through the Melrose contractor from New Hampshire seems to be excluded by the clinical examination made of the handlers of this supply plus the fact that the last date on which this supply went into the K. farm unpasteurized was on August 6. The milk from the S. P. farm can be excluded by the clinical examination.

The infection of this milk supply in all probability took place at the K. farm. The close study of the methods of handling milk at this farm limited the possibilities of infection to a few sources. The drivers of the four milk routes can be practically excluded by reason of the fact that the cases were evenly distributed on all of the routes. J. K., one of the drivers, came down with typhoid fever on August 22. A careful study of this case, clinically and bacteriologically, indicates that this individual was a victim and not the source of infection.

The clinical examinations of all the milkers were negative with the exception noted above. Careful study of the employees of the milk house has not given any positive results.

The only connection between the milk house and the farmhouse is the cloths through which all of the milk is strained when it is brought from the barn. These cloths were washed in the farmhouse by Mrs. K. and sometimes by Mrs. S. So far examinations of these individuals have been negative, but future examinations should be made to satisfactorily settle the question.

Analysis of the water supply of this farm shows pollution. The well was dug by Mr. K., owner of the farm. It has been impossible to trace any human pollution or any connection with typhoid fever cases to this water supply.

Results.

The Lynn board of health promptly excluded the milk from the Lynn market, and continued to exclude it until there was installed at the K. farm a modern pasteurizing plant. The open privy in the barnyard was closed, the milk house screened, the well condemned, and no cases of typhoid fever were reported after the usual period of incubation.

OUTBREAKS AND EPIDEMICS IN THE STATE IN 1916.

The following summaries give the principal facts regarding outbreaks and epidemics of the common communicable diseases occurring during the year. This list is not complete; many of the smaller outbreaks, particularly of measles, scarlet fever and whooping cough, have been omitted. The list of measles outbreaks as printed may be considered rather as illustrative and typical of conditions prevailing throughout the Commonwealth than as a comprehensive record. The same statement holds good in lesser degree as regards scarlet fever and whooping cough.

DIPHTHERIA.

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
July, 1915, to August, 1916.	Shirley,[1] . .	128[2]	Institutional contact.	This outbreak, among 249 boys and 67 officers and employees of the Shirley Industrial School, had a long drawn out, insidious onset, but was finally checked by the authorities in the institution, with the assistance of the epidemiologist of the State Department of Health and a temporary bacteriologist. Wholesale culturing of the institution and immunization of contacts, followed up by special quarantine and isolation regulations, were successful in stamping out the outbreak.
January, ...	Somerset, . .	9	Contact, . .	Investigation by the District Health Officer showed that all cases had been sick over seven days before a physician was called. Quarantine was broken by the families upon which it was placed, thus causing a slight spread. Antitoxin was used, but because of the late call for medical assistance two deaths occurred.
January and February.	Templeton (Baldwinsville).	8	Institutional contact. Unrecognized case.	These cases occurred at the Elliott Colony for Feeble-minded. The first case appeared and died before it was reported. Culturing disclosed seven other clinical cases and many cultural cases. The outbreak was successfully checked by the authorities, with the assistance of the District Health Officer.

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[1] See special investigation by epidemiologist.

[2] Clinical, 8; cultural, 120.

DIPHTHERIA — *Continued.*

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
January to March,	Lowell,	144	Contact,	In this city the disease ran a mild course. It is interesting to note that over half of the cases occurred in children below six years of age, or the school age. The chief reason for spread was the fact that the majority of cases occurred among the foreign population, who would not carry out proper quarantine or allow antitoxin to be given in immunizing doses to the children who had been in contact with the children sick with diphtheria.
January and February.	Leominster,	31	School contact,	Lack of medical school inspection was largely responsible for the headway which this outbreak assumed. Inquiry disclosed the fact that no inspection had been carried out for the year up to the time of investigation. The local board of health took vigorous measures and instituted daily medical supervision, and no more cases occurred.
February,	Andover,	5	Institutional contact.	Four of these cases were at Phillips' Academy. All were cared for at the academy infirmary, and the outbreak was checked by the academy authorities.
April,	Framingham,	8[1]	Institutional contact.	One was a patient at the Framingham Hospital. Cultures of the personnel showed three nurses with "positive" throats, who were isolated.
April to July,	Oxford,	35	School contact. Unrecognized case.	This rather large outbreak for a small community started in a child who carried the germs in her nose but not in her mouth, thus proving the value of taking cultures of every suspect both from nose and throat. She was sick but two or three days. All other cases followed her return to school.
May,	Wrentham,	25	Institutional contact.	A small outbreak at the School for Feeble-minded apparently started from a case among the attendants, one of whom had been visiting outside. It was successfully checked by the authorities of the school.
June,	Salem,	21	School contact. Unrecognized case.	The mild outbreak in this city was a result of a child being in school ill with diphtheria and thus spreading the disease among other scholars before it was recognized.

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[1] Clinical, 5; cultural, 3.

DIPHTHERIA — *Continued.*

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
July,	Boston,	30	Institutional contact.	An outbreak of diphtheria occurred at the Massachusetts General Hospital. The authorities of the institution made special efforts and confined the cases to the employees of the institution, no patient coming down with the disease.
August,	Ludlow,	26	Contact,	A small outbreak of mild cases occurred in the foreign section of this town. Fortunately, this outbreak came just as school was about to open, and medical inspection of each scholar before entering school weeded out the children with suspicious looking throats. Drastic measures were carried out in quarantine and isolation, and the swimming pool in the recreation building of a factory where many of the parents worked was closed.
August to November,	Fitchburg,	86[1]	Contact; lack of medical care.	Diphtheria has been endemic among the tenement houses of this city for a considerable period of time. Investigation invariably shows that physicians are not called at the early stage of the disease, and thus scattered cases continually appear in these districts. Such conditions as this can be successfully coped with only by removing cases to a contagious disease hospital.
September to November.	Westfield,	21	Institutional contact.	At the Westfield State Sanatorium diphtheria appeared, and after the children were given immunizing doses there were no more cases.
October and November.	Winchendon,	8[2]	School contact,	All of these cases occurred in one school. Culturing of the 50 children attending the school disclosed two children and a teacher who had diphtheria bacilli present in their throats.
October to December,	Webster,	31	Contact,	A mild outbreak which caused a persistent cropping up of cases spread over a period of three months. Investigation showed lack of proper isolation and quarantine measures. At first it appeared that milk was not a factor in the spread of the disease, but soon it was noted that milk bottles were being collected from houses that were quarantined for diphtheria, and when this collection was stopped, no more cases were reported.

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[1] Clinical, 80; cultural, 6.

[2] Clinical, 5; cultural, 3.

DIPHTHERIA — *Concluded.*

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
November and December.	Gardner, . .	94[1]	School contact. Unrecognized cases. Common drinking faucet.	A severe school epidemic resulted in a total of 77 cases. Immunizing doses to all contacts helped to check the disease. By means of culturing, 17 carriers were found. These carriers had been sick for a few days, but had no physician, and returned to school, thus spreading the disease among other scholars. A large factor in the spread of this disease, undoubtedly, was the fact that the pupils placed their mouths over a common drinking faucet and spread the disease in this way.
November and December.	Adams, . .	10	Contact, . .	Two of these cases visited a home in Williamstown where three children were recovering from diphtheria, and thus became sick two or three days later.
December, . .	Canton, . .	8	Contact. Unrecognized case.	A small outbreak due to an unrecognized case caused eight other cases.
December, . .	Holyoke, . .	23[2]	Institutional contact.	This outbreak was the result of a nurse in the City Hospital having diphtheria. The authorities of the institution immediately had cultures taken from all patients with the result that eleven "positive" throats were discovered out of twenty-six patients. There were no clinical cases among the patients, however.

[1] Clinical, 77; cultural, 17.

[2] Clinical, 12; cultural, 11.

Summary.

Total number of outbreaks,	20
Clinical cases,	591
Cultural cases,	160
Total cases,	751
Sources of outbreaks: —	
General contact,	7
School,	5
Institutional,	8
Total,	20

MEASLES.

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
January, . . .	Canton, . .	29	Institutional contact.	An outbreak occurred in the Massachusetts Hospital School. Inquiry showed that the first case was in a child who returned, after vacation, to school from her home, where there was a case of measles. The other cases appeared after her illness began.
December, 1915, and January, 1916.	Swampscott, .	162	Contact, . .	Many families in this town had no physician attending the sick children, and for this reason the cases spread.
January and February.	Dennis, . .	78	School contact, .	The local authorities took strict measures, and the cases were confined to one school district.
December, 1915, to February, 1916.	Webster, . .	42	School contact, .	The cases in this outbreak were confined to two school districts prior to the Christmas vacation. Placarding the houses for measles by local board of health proved to be of great assistance in preventing the spread of the outbreak.
January to May, .	Lynn, ...	1,008	School contact, .	The disease was present all over the city, and efforts to control it were unavailing. The local authorities with five extra inspectors attempted to visit and follow up all cases of sickness in this epidemic.
February to May, .	Adams, . .	62	Contact. Unrecognized cases.	The first cases appeared among the foreign population, who failed to appreciate the seriousness of the disease and neglected to call in medical assistance to attend to the sick. The outbreak came in two waves, — February and April. In the month of March only three cases were reported.
January to September.	Fitchburg, . .	479	Contact. Unrecognized cases.	The outbreak appeared in the French section of the city, and later spread all over the community. The epidemic appeared on the wane in May, but increased again in June. The spread was undoubtedly due to lack of quarantine, and this was due to non-reporting of cases by householders who had no physician in attendance.
March to May, . .	Ludlow, . .	199	Contact, . .	This outbreak ran a straight course from the start. When the disease had exhausted susceptible material it died out.
February to July, .	Newton, . .	431	School contact. Unrecognized cases.	The cases reported were chiefly among the pupils of two schools. The mild course the disease ran was apparently the reason for the great spread, due to unrecognized cases.

MEASLES — *Concluded.*

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
February to July,	Framingham,	164	Contact,	Special efforts were made to prevent the spread of the outbreak. Each case was visited and instruction given as to preventive measures, and houses were placarded.
February to June,	Springfield,	1,286	Contact,	Attempts were made by the local board to control the epidemic by instruction and follow-up work. Careful measures were taken to exclude sick children from the playgrounds.
March to May,	Whitman,	444	School contact,	An effort was made to get a reporting of every case. Placarding was adopted and proved an aid in quarantine.
April and May,	Hanson,	36	Contact,	The few cases reported from this town were scattered among all the schools.
May,	Warren,	70	Contact. Unreported case.	Neglect of a physician to report a case led to this outbreak, as quarantine was not placed early enough.
May,	Hanover,	32	- -	Poor reporting by householders was shown in this town. The epidemic spread from adjoining town.
June,	North Adams,	194	Contact,	Because of the fact that school was not in session it was difficult to control the epidemic. The epidemic apparently spread to this city from an adjoining community.
June to December,	Leominster,	230	Contact,	The cases were scattered all over the city. Medical assistance was not called in, and a child would return to school after a day's illness and thus spread the infection among the other pupils. There were really two outbreaks, as but one case was reported in September.
July,	Grafton,	24	Institutional contact.	A small outbreak occurred at the State hospital.
November and December.	Ayer,	90	Contact. Unrecognized case.	Investigation showed that most of the cases did not have medical attendance, and no precautions were taken against spread.
January,	Chelsea,	221	Contact,	Outbreak started from a church supper and play in December, the infection becoming widely spread in this way.

Summary.

Total number of outbreaks,	20
Total number of cases,	5,281
Sources of outbreaks: —	
General contact,	13
School,	5
Institutional,	2
Total,	20

SCARLET FEVER.

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
January to March, .	Greenfield, . .	22	School contact. Unrecognized mild cases.	A survey of the situation here showed that parents did not recognize the necessity of keeping mild cases quarantined at home. The outbreak was kept under control by the school physician, who weeded out the mild cases after the spring vacation.
January to March, .	Montague, . .	17	Contact. Unrecognized mild cases.	The persistent appearing of cases in the Turners Falls section was a result of families of foreign nationality not calling in medical assistance, and thus the children sick with the disease were allowed to roam at large.
December, 1915, to May, 1916.	Quincy, . .	225	School contact, .	No common focus for this epidemic was found. It was shown that school inspection carried out by one nurse in a city the size of Quincy was inadequate to handle such a problem as an epidemic of this nature presented. Lack of funds for use of local board of health also crippled the board's activity. The spread was largely due to mild cases and the fact that foreign population would not call in a physician at the beginning of the disease.
January to April, .	Brookline, . .	50	School contact, .	A mild outbreak handled in a drastic way by the local board of health prevented it from assuming wide proportions.
January and February.	Framingham, .	20	School contact, .	The outbreak was scattered throughout the schools of the town, but failed to assume epidemic proportions.
January, . . .	Leominster, . .	18	School contact, .	A small outbreak started in November, 1915, and continued, largely due to the fact that too much dependence was placed on school teachers for weeding out suspicious cases of the disease, instead of calling in a physician to handle the problem.
January and February.	Northampton (Clark School for Deaf).	14	School contact, .	Several cases of scarlet fever appeared in the school, and the District Health Officer was called in by the authorities, and he advised methods of procedure. Drastic quarantine and isolation was carried out, and no more cases appeared among the 74 children and adults who lived at the institution.
February, . . .	Hardwick, . .	6	School contact. Unrecognized cases.	All of these cases were in one school, and the school was closed by the local authorities, as medical inspection was inadequate.

SCARLET FEVER — *Continued.*

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
April, . . .	Natick, . .	7	Institutional contact.	Two nurses became sick with scarlet fever, followed by the appearance of the disease in two patients. Action by the local hospital authorities showed that three nurses had suspicious throats, and they were isolated until their throats became normal. Hospital was cleaned, scrubbed and painted, and no new cases appeared.
May, ...	Clinton and Lancaster.	11	Contact and milk,	Four of these cases appeared prior to a case in a child in the family of a dairyman. The resulting cases all bought milk from this same dairyman.
May, ...	Dalton, . .	9	School contact. Unrecognized case.	The first case reported was not recognized, and had been continuing in attendance at school, the resulting cases obtaining the infection from this unrecognized case. Medical inspection of the school, and exclusion of those with suspicious looking throats, stopped the outbreak.
May and June, . .	Wrentham, . .	4	Institutional contact.	Source not clear. Outbreak in State School for Feeble-minded.
June, . . .	Peabody, . .	18	School contact, .	Two mild cases occurred in one school. A diagnosis of measles in the first one or two cases caused a spread of the outbreak at first. Medical inspection by the local authorities soon had the outbreak under control.
September to December.	Westfield, . .	60	Evasion of quarantine.	The cases appeared in the foreign section of Westfield, and these people did not appreciate the seriousness of scarlet fever. They attempted to treat the disease with home treatment, with the result that quarantine was not enforced and sick children played with the other children, thus spreading the disease.
October to December,	Montague, . .	24	Contact, . .	Scattered cases occurred in Montague, most of the cases appearing among the foreign population. Lack of medical assistance at the beginning of a case was responsible for the continual appearance of these cases. The cases were reported chiefly from the western section of the town, and were apparently connected with the Greenfield cases.

SCARLET FEVER — *Concluded.*

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
November and December.	Woburn,	27	School contact. Unrecognized cases.	Practically all of these cases occurred in one school in the city, and supervision of the children by school physicians prevented the appearance of further cases. The disease appeared in this city in September and gradually spread, due to unrecognized and missed cases, and thus assumed outbreak proportions. The spread was largely due to the fact that medical assistance was not called in at the beginning of the sickness.
December,	Wareham,	5	Contact,	Failure on the part of a physician to recognize, diagnose and report a case resulted in a small outbreak in this town.
December,	Greenfield,	17	Contact,	The cases were mild and chiefly among the foreign population. The outbreak appears to be connected with the Montague cases.

Summary.

Total number of outbreaks,	18
Total number of cases,	554
Sources of outbreaks: —	
School,	10
Institutional,	2
Milk,	1
General contact,	5
Total,	18

SMALLPOX.

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
March to May,	Fitchburg,	12	Contact,	The cases were among mill workers, and were taken care of in the smallpox hospital.
August to November,	Lee and Great Barrington.	18	Contact,	The first case was in a person who arrived in Great Barrington in August from Connecticut, sick with what was diagnosed as chicken pox. When nine cases resulted the following eight weeks it was then recognized as smallpox. Vaccination and quarantine were carried out, but nine more cases appeared in the following two weeks.

Summary.

Total number of outbreaks,	2
Total number of cases,	30
Sources of outbreaks: —	
General contact,	2

TYPHOID FEVER.

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
January, . . .	Lawrence and Methuen.	19	Never definitely determined; probably water infection.	Investigation showed the cases were widely distributed and supplied by fifteen different milk dealers. One of the drinking water filter beds was being worked about double its capacity, and large numbers of *B. Coli* were found. Lawrence supplied water for Methuen on December 22 and 23, when Methuen was short of water.
January, . . .	North Chelmsford,	2	Well water, . .	Two cases of typhoid occurred in two separate families using water from the same well. Laboratory examination showed large numbers of *B. Coli* in the water.
February, . . .	Wellesley, . .	2	Carrier, . .	A carrier was found in a family.
June, . . .	Whitman and East Bridgewater.	5	Milk carrier, .	An individual who handled milk had typhoid thirty years previously, and was found to be a carrier with positive Widal and positive bile culture of feces. This person stopped handling the milk, and no more cases occurred.
August, . . .	Nantucket, . .	9	Milk carrier, .	A carrier was found in the employ of one of the two dealers who supplied milk to the families in which the cases of typhoid occurred. This carrier gave a positive Widal and positive bile culture of feces. He was discharged, and no more cases of typhoid appeared.
August and September.	Lynn, . . .	114[1]	Milk, . . .	Investigation showed all the cases to be on the route of one milk dealer. The epidemic ceased after the suspected milk supply was stopped. No definite source of the outbreak, such as a carrier or case, was found.
December, 1915, and January, 1916.	Fall River, . .	38	Milk bottles, .	Investigation showed that a milk dealer in Tiverton, R. I., had been delivering milk in other towns to houses where there were typhoid fever cases, and that the bottles were not properly sterilized before being refilled. The 38 cases were all on the milk route of this dealer. No cases or carriers were found at the milk farm, but there was a badly polluted well.

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[1] See special investigation by epidemiologist.

Summary.

Total number of outbreaks,	7
Total number of cases,	189
Sources of outbreaks: —	
Typhoid carriers (through milk),	2
Milk,	2
Carrier (personal contact),	1
Water (well),	1
Undetermined,	1
Total,	7

WHOOPING COUGH.

DATE.	Locality.	Cases.	Method of Infection.	Brief History of Outbreak.
January,	New Marlborough,	33	School contact,	A doctor from a neighboring town was called by the parent of a child sick with whooping cough. He was informed that all children at school were sick with the same disease. This is one of the small towns of the State, with no resident physician.
February to May,	Sheffield,	107	School contact,	The epidemic spread from a neighboring town. Successful efforts were made to confine the cases to one school and to get a complete reporting of all cases by the local authorities.
January to March,	Milford,	32	Contact,	Bad reporting was responsible for the small number of cases reported in this epidemic, which spread over the greater part of the town.
January to April,	Newton,	85	Contact,	This outbreak was largely confined to the western section of the town.
February,	Spencer,	14	School contact. Unrecognized case.	Pupils sick with whooping cough attended school. Investigation showed practically every child attending school sick.
March to September,	Haverhill,	123	Playground contact.	This outbreak which started early in the year did not develop rapidly, but existed through the summer until school began in the fall. It was largely confined to one ward of the city.
September to November.	Clinton,	56	School contact,	By the efforts of the local authorities the outbreak was kept within one school district.

Summary.

Total number of outbreaks,	7
Total number of cases,	450
Sources of outbreaks: —	
General contact,	2
School,	4
Playground,	1
Total,	7

INCIDENCE OF COMMUNICABLE DISEASES BY MONTHS, 1916.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Actinomycosis,	1	–	–	–	–	1	–	1	–	1	–	–	4
Anterior poliomyelitis,	6	3	5	2	4	10	106	252	623	701	179	36	1,927
Anthrax,	–	2	9	4	3	5	–	2	–	3	1	2	31
Chicken pox,	755	577	565	457	488	397	207	63	68	121	355	619	4,672
Diphtheria,	840	711	692	610	543	555	418	480	463	595	593	782	7,282
Dog bite (requiring antirabic treatment),	3	1	4	4	13	9	9	6	7	6	4	5	71
Dysentery,	1	1	–	–	4	1	18	25	31	18	14	6	119
Cerebrospinal meningitis,	14	16	15	13	11	19	10	6	16	11	9	10	150
German measles,	28	30	46	68	152	160	38	11	7	5	23	23	591
Ophthalmia neonatorum,	197	158	205	143	173	148	184	163	140	144	146	131	1,932[1]
Leprosy,	–	–	–	1	–	–	–	1	–	–	–	–	2
Malaria,	3	1	1	4	5	13	7	12	19	6	22	4	97
Measles,	1,866	1,934	3,399	4,169	4,438	4,187	2,670	582	181	252	724	1,058	25,460
Mumps,	178	144	313	307	245	189	127	48	43	100	178	446	2,318
Pellagra,	–	3	4	5	6	7	4	5	5	3	3	2	47
Scarlet fever,	948	772	879	696	703	433	218	154	201	305	376	586	6,271
Septic sore throat,	18	22	34	11	15	6	6	7	5	7	14	14	159
Smallpox,	1	–	3	6	1	1	–	–	–	5	14	1	32
Tetanus,	–	2	3	2	2	4	3	3	2	4	6	3	34
Trachoma,	4	1	5	7	4	7	10	10	12	7	10	11	88
Trichinosis,	3	3	4	1	–	–	–	–	–	–	13	–	24
Tuberculosis, pulmonary,	667	685	702	647	722	689	730	624	622	532	540	718	7,878
Tuberculosis, other forms,	49	43	57	68	61	65	73	47	57	51	43	43	657
Typhoid fever,	81	38	55	54	77	72	128	268	369	179	115	79	1,515
Whooping cough,	983	792	1,026	656	732	536	499	402	277	171	201	172	6,447
	6,646	5,939	8,026	7,935	8,402	7,514	5,465	3,172	3,148	3,227	3,583	4,751	67,808

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[1] Including 196 cases of suppurative conjunctivitis.

CASES AND DEATHS FROM DISEASES DANGEROUS TO THE PUBLIC HEALTH, 1916.

Index to Line Numbers in the Table of Cases and Deaths from Diseases Dangerous to the Public Health, 1916.

109 Abington.
194 Acton.
179 Acushnet.
56 Adams.
127 Agawam.
354 Alford.
81 Amesbury.
111 Amherst.
83 Andover.
48 Arlington.
200 Ashburnham.
291 Ashby.
282 Ashfield.
196 Ashland.
70 Athol.
40 ATTLEBORO.
145 Auburn.
191 Avon.
165 Ayer.

121 Barnstable.
142 Barre.
285 Becket.
248 Bedford.
199 Belchertown.
204 Bellingham.
80 Belmont.
284 Berkley.
294 Berlin.
297 Bernardston.
36 BEVERLY.
146 Billerica.
108 Blackstone.
315 Blandford.
304 Bolton.
3 BOSTON.
169 Bourne.
345 Boxborough.
306 Boxford.
298 Boylston.
74 Braintree.
296 Brewster.
72 Bridgewater.
290 Brimfield.
16 BROCKTON.
203 Brookfield.
29 Brookline.
232 Buckland.
301 Burlington.

9 CAMBRIDGE.
106 Canton.
327 Carlisle.
223 Carver.
286 Charlemont.
190 Charlton.
225 Chatham.
120 Chelmsford.
21 CHELSEA.
233 Cheshire.
256 Chester.
317 Chesterfield.
31 CHICOPEE.
351 Chilmark.
277 Clarksburg.
57 Clinton.
160 Cohasset.
212 Colrain.
95 Concord.
266 Conway.
309 Cummington.

137 Dalton.
307 Dana.
64 Danvers.
114 Dartmouth.
65 Dedham.
156 Deerfield.
218 Dennis.
178 Dighton.
193 Douglas.
280 Dover.
134 Dracut.
129 Dudley.
341 Dunstable.
206 Duxbury.

138 East Bridgewater.
201 East Longmeadow.
319 Eastham.
69 Easthampton.
123 Easton.
259 Edgartown.
316 Egremont.
302 Enfield.
270 Erving.
226 Essex.
26 EVERETT.

99 Fairhaven.
7 FALL RIVER.
135 Falmouth.
25 FITCHBURG.
330 Florida.
139 Foxborough.
47 Framingham.
97 Franklin.
224 Freetown.

45 Gardner.
359 Gay Head.
197 Georgetown.
288 Gill.
35 GLOUCESTER.
352 Goshen.
361 Gosnold.
101 Grafton.
295 Granby.
303 Granville.
93 Great Barrington.
58 Greenfield.
334 Greenwich.
186 Groton.
184 Groveland.

162 Hadley.
311 Halifax.
209 Hamilton.
308 Hampden.
322 Hancock.
168 Hanover.
219 Hanson.
141 Hardwick.
276 Harvard.
192 Harwich.
164 Hatfield.
18 HAVERHILL.
333 Hawley.
336 Heath.
118 Hingham.
260 Hinsdale.

Index to Line Numbers in the Table of Cases and Deaths from Diseases Dangerous to the Public Health, 1916 — Continued.

153 Holbrook.
174 Holden.
360 Holland.
163 Holliston.
17 HOLYOKE.
167 Hopedale.
182 Hopkinton.
278 Hubbardston.
94 Hudson.
187 Hull.
244 Huntington.

100 Ipswich.

173 Kingston.

231 Lakeville.
172 Lancaster.
275 Lanesborough.
14 LAWRENCE.
128 Lee.
147 Leicester.
149 Lenox.
42 LEOMINSTER.
300 Leverett.
110 Lexington.
343 Leyden.
253 Lincoln.
264 Littleton.
217 Longmeadow.
10 LOWELL.
98 Ludlow.
227 Lunenburg.
13 LYNN.
272 Lynnfield.

20 MALDEN.
151 Manchester.
105 Mansfield.
84 Marblehead.
237 Marion.
49 MARLBOROUGH.
222 Marshfield.
355 Mashpee.
249 Mattapoisett.
92 Maynard.
140 Medfield.
30 MEDFORD.
155 Medway.
44 MELROSE.
289 Mendon.
198 Merrimac.
51 Methuen.
79 Middleborough.
346 Middlefield.
251 Middleton.
54 Milford.
116 Millbury.
241 Millis.
78 Milton.
348 Monroe.
122 Monson.
82 Montague.
342 Monterey.
356 Montgomery.
363 Mount Washington.

243 Nahant.
150 Nantucket.
66 Natick.
91 Needham.
362 New Ashford.
8 NEW BEDFORD.
328 New Braintree.
281 New Marlborough.
313 New Salem.
229 Newbury.
50 NEWBURYPORT.
22 NEWTON.
254 Norfolk.
38 NORTH ADAMS.
102 North Andover.
76 North Attleborough.
154 North Brookfield.
252 North Reading.
37 NORTHAMPTON.
215 Northborough.
77 Northbridge.
216 Northfield.
175 Norton.
230 Norwell.
63 Norwood.

261 Oak Bluffs.
323 Oakham.
117 Orange.
267 Orleans.
332 Otis.
144 Oxford.

73 Palmer.
325 Paxton.
39 Peabody.
324 Pelham.
255 Pembroke.
157 Pepperell.
358 Peru.
305 Petersham.
337 Phillipston.
24 PITTSFIELD.
338 Plainfield.
245 Plainville.
59 Plymouth.
314 Plympton.
350 Prescott.
299 Princeton.
132 Provincetown.

23 QUINCY.
126 Randolph.
213 Raynham.
90 Reading.
188 Rehoboth.
33 REVERE.
320 Richmond.
269 Rochester.
89 Rockland.
130 Rockport.
335 Rowe.
236 Rowley.
293 Royalston.
273 Russell.
208 Rutland.

27 SALEM.
221 Salisbury.
318 Sandisfield.
240 Sandwich.
67 Saugus.
321 Savoy.
170 Scituate.
159 Seekonk.
180 Sharon.
211 Sheffield.
239 Shelburne.
220 Sherborn.
189 Shirley.
152 Shrewsbury.
349 Shutesbury.
143 Somerset.
15 SOMERVILLE.
119 South Hadley.
287 Southampton.
207 Southborough.
52 Southbridge.
242 Southwick.
107 Spencer.
11 SPRINGFIELD.
246 Sterling.
210 Stockbridge.
86 Stoneham.
88 Stoughton.
274 Stow.
235 Sturbridge.
265 Sudbury.
257 Sunderland.
166 Sutton.
85 Swampscott.
171 Swansea.

28 TAUNTON.
133 Templeton.
113 Tewksbury.
250 Tisbury.
357 Tolland.
271 Topsfield.
214 Townsend.
310 Truro.
283 Tyngsborough.
347 Tyringham.

Index to Line Numbers in the Table of Cases and Deaths from Diseases Dangerous to the Public Health, 1916 — Concluded.

202 Upton.
125 Uxbridge.

60 Wakefield.
344 Wales.
112 Walpole.
32 WALTHAM.
75 Ware.
115 Wareham.
131 Warren.
326 Warwick.
353 Washington.
43 Watertown.
205 Wayland.
61 Webster.
96 Wellesley.
292 Wellfleet.
340 Wendell.
279 Wenham.
258 West Boylston.
158 West Bridgewater.
262 West Brookfield.
234 West Newbury.
62 West Springfield.
263 West Stockbridge.
329 West Tisbury.
103 Westborough.
41 Westfield.
161 Westford.
331 Westhampton.
228 Westminster.
185 Weston.
148 Westport.
238 Westwood.
53 Weymouth.
268 Whately.
87 Whitman.
177 Wilbraham.
195 Williamsburg.
136 Williamstown.
183 Wilmington.
104 Winchendon.
68 Winchester.
339 Windsor.
55 Winthrop.
46 WOBURN.
5 WORCESTER.
312 Worthington.
176 Wrentham.

247 Yarmouth.

Cases and Deaths from Diseases Dangerous

Line No.	CITIES AND TOWNS GROUPED IN ORDER OF POPULATION.	Population estimated as of July 1, 1916.	63A Poliomyelitis.		19A Chicken Pox.		61A Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
1	Massachusetts,	3,779,033	1,927	**452**	4,672	**5**	150	**136**	7,282	**629**	591	**1**	25,460	**392**
2	CITIES OVER 500,000.													
3	Boston,	763,529	491	**161**	1,399	**1**	51	**44**	1,951	**194**	111	–	5,294	**105**
4	CITIES, 150,000–500,000.													
5	Worcester,	166,735	24	**5**	52	**1**	8	**7**	361	**24**	2	**1**	1,168	**52**
6	CITIES, 100,000–150,000.	*563,343*	*209*	*33*	*550*	*1*	*29*	*24*	*1,111*	*109*	*151*	–	*3,770*	*84*
7	Fall River,	126,119	12	**2**	81	–	8	**3**	133	**20**	5	–	588	**25**
8	New Bedford,	112,689	19	**1**	79	–	2	**6**	117	**11**	6	–	260	**12**
9	Cambridge,	109,785	72	**3**	218	**1**	7	**2**	374	**15**	24	–	453	**5**
10	Lowell,	108,385	17	**4**	43	–	8	**9**	309	**45**	91	–	1,177	**28**
11	Springfield,	106,365	89	**23**	129	–	4	**4**	178	**18**	25	–	1,292	**14**
12	CITIES, 50,000–100,000.	*453,749*	*230*	*64*	*532*	–	*13*	*10*	*1,106*	*98*	*38*	–	*4,341*	*52*
13	Lynn,	97,366	44	**16**	98	–	3	**2**	273	**20**	5	–	1,030	**13**
14	Lawrence,	91,314	7	**2**	108	–	2	**4**	260	**24**	7	–	420	**17**
15	Somerville,	89,178	48	**9**	83	–	5	**2**	151	**23**	5	–	119	**3**
16	Brockton,	63,590	3	–	186	–	–	–	159	**6**	6	–	2,267	**18**
17	Holyoke,	61,562	116	**34**	16	–	1	–	97	**10**	9	–	382	**1**
18	Haverhill,	50,739	12	**3**	41	–	2	**2**	166	**15**	6	–	123	–
19	CITIES AND TOWNS, 25,000–50,000.	*534,149*	*357*	*65*	*694*	–	*14*	*14*	*1,019*	*79*	*72*	–	*2,308*	*8*
20	Malden,	49,996	46	**11**	52	–	1	**1**	175	**11**	21	–	201	–
21	Chelsea,	46,078	8	**2**	60	–	3	**1**	59	**6**	–	–	251	**2**
22	Newton,	43,912	21	**4**	62	–	2	**2**	46	**1**	1	–	455	**1**
23	Quincy,	42,615	66	**15**	45	–	–	–	66	**1**	6	–	79	**1**
24	Pittsfield,	41,416	67	**14**	65	–	1	**1**	53	**9**	4	–	17	–
25	Fitchburg,	40,098	10	**3**	35	–	1	**2**	197	**21**	1	–	582	–
26	Everett,	38,741	29	**1**	46	–	1	**3**	106	**2**	6	–	60	–
27	Salem,	38,662	9	**1**	80	–	1	**2**	55	**2**	–	–	155	–
28	Taunton,	36,621	4	–	19	–	1	–	32	**8**	3	–	52	**2**
29	Brookline,	34,867	21	**5**	72	–	–	–	25	–	1	–	122	**1**
30	Medford,	32,286	19	**6**	107	–	–	–	32	**1**	9	–	85	–
31	Chicopee,	31,283	15	–	11	–	3	**2**	62	**11**	19	–	191	–
32	Waltham,	30,715	27	**3**	39	–	–	–	48	**6**	1	–	52	**1**
33	Revere,	26,859	15	–	1	–	–	–	63	–	–	–	6	–
34	CITIES AND TOWNS, 10,000–25,000.	*547,500*	*287*	*62*	*554*	–	*16*	*19*	*883*	*62*	*60*	–	*2,941*	*42*
35	Gloucester,	24,497	6	**3**	2	–	–	–	21	**1**	1	–	110	**2**
36	Beverly,	24,001	23	**6**	29	–	–	**1**	31	–	–	–	33	**1**
37	Northampton,	22,191	12	**4**	26	–	1	**1**	11	**3**	5	–	177	**4**
38	North Adams,	22,039	38	**13**	9	–	1	**1**	5	**1**	–	–	216	**1**
39	Peabody,	19,327	3	**1**	26	–	–	–	18	**2**	2	–	112	–
40	Attleboro,	19,027	2	**1**	11	–	–	–	46	**4**	–	–	287	**3**
41	Westfield,	18,983	14	**1**	41	–	2	**1**	54	**5**	–	–	45	**1**
42	Leominster,	17,662	4	–	45	–	–	–	66	**7**	–	–	237	**1**
43	Watertown,	17,395	2	**1**	8	–	–	–	54	**1**	2	–	22	**3**

to the Public Health, 1916.

19C		38A¹		7		28-29		30-35		1		8		14		4		100		75A		
Mumps.		Ophthalmia Neonatorum.		Scarlet Fever.		Tuberculosis, Pulmonary.		Tuberculosis, Other Forms.		Typhoid Fever.		Whooping Cough.		Dysentery.		Malaria.		Septic Sore Throat.		Trachoma.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
2,318	3	1,932	–	6,271	127	7,878	4,575	657	846	1,515	172	6,447	346	119	79	97	4	159	67	88	–	1
																						2
729	1	652	–	1,348	41	2,256	1,094	207	216	165	26	1,382	75	86	10	17	–	64	22	50	–	3
																						4
57	–	116	–	273	3	372	218	36	62	39	6	46	9	2	4	4	–	–	2	5	–	5
440	*2*	*405*	–	*731*	*17*	*1,473*	*761*	*110*	*146*	*403*	*43*	*797*	*44*	*3*	*14*	*32*	*2*	*14*	*10*	*8*	–	6
16	1	98	–	88	3	441	201	15	32	221	14	179	12	1	9	27	2	8	1	–	–	7
93	–	107	–	121	2	369	170	35	42	65	8	81	13	1	1	–	–	1	1	–	–	8
189	–	81	–	171	2	309	194	13	13	27	2	379	9	1	–	2	–	4	2	2	–	9
7	–	52	–	102	6	196	123	22	36	61	13	25	8	–	4	–	–	–	3	6	–	10
135	1	67	–	249	4	158	73	25	23	29	6	133	2	–	–	3	–	1	3	–	–	11
166	–	*235*	–	*791*	*16*	*890*	*497*	*97*	*104*	*279*	*28*	*829*	*37*	*20*	*9*	*1*	–	*15*	*10*	*3*	–	12
18	–	47	–	276	6	177	102	15	13	155	9	35	4	–	1	–	–	2	4	–	–	13
8	–	23	–	100	5	205	128	31	26	70	8	86	8	–	2	–	–	2	1	1	–	14
55	–	46	–	117	2	160	91	20	19	16	1	108	8	–	–	–	–	4	1	1	–	15
82	–	42	–	67	–	135	42	9	11	18	1	422	4	–	1	–	–	1	2	1	–	16
–	–	17	–	146	1	124	80	5	23	6	5	13	7	–	–	–	–	–	1	–	–	17
3	–	60	–	85	2	89	54	17	12	14	4	165	6	20	5	1	–	6	1	–	–	18
217	–	*244*	–	*956*	*21*	*1,051*	*457*	*105*	*108*	*176*	*18*	*984*	*56*	*2*	*16*	*22*	*2*	*11*	*10*	*10*	–	19
–	–	42	–	82	2	96	21	7	7	15	4	59	5	–	1	–	–	–	2	–	–	20
39	–	60	–	80	1	120	46	9	5	29	3	72	6	–	2	3	1	3	1	3	–	21
40	–	12	–	41	–	42	17	12	5	27	1	112	1	2	1	11	–	2	2	–	–	22
37	–	11	–	222	4	93	37	1	12	9	–	47	1	–	1	–	–	1	–	–	–	23
21	–	14	–	38	1	80	33	6	3	11	–	48	1	–	–	–	–	–	–	–	–	24
4	–	14	–	54	–	87	33	22	10	14	4	119	6	–	–	–	–	–	–	3	–	25
5	–	26	–	87	2	102	36	7	7	16	–	99	3	–	1	1	–	–	–	–	–	26
4	–	19	–	37	1	116	47	20	11	2	3	98	3	–	2	–	–	–	2	1	–	27
3	–	3	–	46	2	81	74	2	14	10	1	15	6	–	3	2	1	2	1	2	–	28
10	–	4	–	76	1	54	24	5	3	5	–	109	2	–	–	–	–	2	–	1	–	29
29	–	12	–	56	1	27	14	3	7	8	–	46	4	–	–	–	–	–	1	–	–	30
3	–	11	–	56	2	98	35	7	10	10	–	32	12	–	4	–	–	1	–	–	–	31
22	–	9	–	57	2	30	29	3	11	13	2	125	6	–	1	5	–	–	1	–	–	32
–	–	7	–	24	2	25	11	1	3	7	–	3	–	–	–	–	–	–	–	–	–	33
311	–	*118*	–	*1,064*	*15*	*730*	*436*	*43*	*96*	*231*	*27*	*798*	*54*	*5*	*11*	*5*	–	*21*	*11*	*7*	–	34
17	–	3	–	5	–	34	18	1	5	7	1	37	14	–	–	–	–	–	–	–	–	35
2	–	1	–	11	–	39	11	2	1	18	1	11	–	–	–	–	–	–	1	–	–	36
14	–	6	–	63	2	77	37	2	2	13	2	43	2	–	1	–	–	–	1	–	–	37
–	–	2	–	54	1	29	16	3	2	30	6	6	–	–	–	–	–	–	–	–	–	38
–	–	5	–	48	7	41	7	1	5	7	1	10	1	–	–	–	–	–	1	–	–	39
1	–	3	–	34	–	32	16	6	4	13	1	10	1	–	–	–	–	–	–	2	–	40
6	–	6	–	79	2	35	58	3	2	8	3	23	2	–	–	–	–	7	–	–	–	41
6	–	5	–	55	–	41	11	2	5	6	1	25	1	–	–	–	–	–	–	2	–	42
52	–	8	–	20	–	11	9	2	4	8	–	2	–	–	–	1	–	–	3	–	–	43

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[1] Including 196 cases of suppurative conjunctivitis.

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1916.	63A Poliomyelitis.		19A Chicken Pox.		61A Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
44	Melrose,	17,161	17	**3**	26	–	–	–	14	**1**	5	–	11	–
45	Gardner,	16,781	4	–	43	–	1	**3**	94	**6**	1	–	168	**3**
46	Woburn,	16,676	5	–	3	–	–	–	38	**6**	–	–	14	**3**
47	Framingham,	16,564	4	–	65	–	–	**1**	27	**1**	1	–	403	–
48	Arlington,	15,784	8	**1**	10	–	2	–	13	–	3	–	20	–
49	Marlborough,	15,412	3	**2**	5	–	1	**3**	13	**1**	–	–	23	–
50	Newburyport,	15,398	22	**6**	15	–	–	–	8	–	2	–	14	–
51	Methuen,	14,625	3	–	9	–	2	–	28	**1**	–	–	84	**1**
52	Southbridge,	14,605	5	–	1	–	1	**1**	42	**4**	1	–	16	**1**
53	Weymouth,	14,229	6	**1**	–	–	–	**1**	3	**1**	–	–	2	–
54	Milford,	13,836	4	–	11	–	–	–	15	**1**	1	–	10	–
55	Winthrop,	13,393	4	**1**	9	–	–	–	13	–	21	–	206	**1**
56	Adams,	13,264	15	**2**	5	–	–	**1**	20	**2**	1	–	77	**3**
57	Clinton,	13,220	1	–	13	–	1	–	5	**1**	–	–	74	**3**
58	Greenfield,	13,152	5	**1**	13	–	3	**2**	5	–	2	–	15	–
59	Plymouth,	13,116	1	–	–	–	–	**1**	16	**1**	1	–	18	**2**
60	Wakefield,	13,114	12	**7**	4	–	–	–	12	–	–	–	9	–
61	Webster,	12,820	5	–	6	–	–	–	36	–	1	–	45	**3**
62	West Springfield,	11,850	10	**2**	3	–	–	–	38	**6**	–	–	92	**4**
63	Norwood,	11,693	3	–	8	–	–	**1**	26	–	8	–	15	–
64	Danvers,	11,601	2	–	22	–	–	–	1	–	1	–	42	–
65	Dedham,	11,468	18	**2**	31	–	–	–	12	**2**	1	–	19	–
66	Natick,	11,442	3	–	12	–	–	–	43	**2**	–	–	19	–
67	Saugus,	10,753	6	–	5	–	–	–	4	–	–	–	223	**2**
68	Winchester,	10,173	8	–	37	–	1	**1**	30	–	–	–	13	–
69	Easthampton,	10,164	6	**2**	1	–	–	–	16	**1**	–	–	61	–
70	Athol,	10,084	3	**2**	–	–	–	–	5	**1**	–	–	9	–
71	Towns, 5,000-10,000.	*355,569*	*159*	*29*	*517*	*1*	*12*	*11*	*427*	*29*	*83*	–	*3,018*	*22*
72	Bridgewater,	9,790	3	–	14	–	–	–	20	–	1	–	196	4
73	Palmer,	9,675	4	**1**	–	–	–	–	10	**1**	–	–	130	–
74	Braintree,	9,652	8	**2**	22	–	–	–	6	–	3	–	11	–
75	Ware,	9,466	–	–	–	–	–	–	5	**1**	–	–	23	**3**
76	North Attleborough,	9,437	3	–	1	–	–	**1**	29	**2**	2	–	15	–
77	Northbridge,	9,362	1	–	–	–	–	–	11	**1**	–	–	45	**1**
78	Milton,	8,763	11	**1**	36	–	–	**1**	12	–	11	–	34	–
79	Middleborough,	8,732	3	–	51	–	–	–	6	**1**	–	–	84	–
80	Belmont,	8,695	5	**1**	54	–	–	–	11	**1**	4	–	151	**1**
81	Amesbury,	8,217	22	**3**	7	–	–	–	18	**1**	1	–	29	**1**
82	Montague,	8,181	7	–	1	–	–	–	3	–	–	–	57	**2**
83	Andover,	8,142	2	–	5	–	–	–	12	–	2	–	10	–
84	Marblehead,	7,671	1	–	–	–	–	–	2	**1**	–	–	185	**1**
85	Swampscott,	7,621	5	–	17	–	–	–	14	–	3	–	104	–
86	Stoneham,	7,585	5	**1**	3	–	–	–	14	**1**	–	–	6	–
87	Whitman,	7,575	1	–	5	–	–	–	1	–	–	–	458	–
88	Stoughton,	7,143	4	**1**	1	–	–	**2**	4	–	–	–	34	**1**
89	Rockland,	7,109	1	–	1	–	2	–	2	**1**	–	–	127	**1**
90	Reading,	7,044	2	–	1	–	–	**1**	21	–	–	–	121	**1**
91	Needham,	6,908	–	–	24	–	–	–	5	**1**	–	–	31	**1**
92	Maynard,	6,862	1	–	3	–	–	–	6	–	–	–	9	**1**
93	Great Barrington,	6,796	1	–	1	–	–	–	–	–	–	–	8	–
94	Hudson,	6,762	2	–	1	–	1	**1**	6	**1**	–	–	23	–
95	Concord,	6,744	1	–	2	–	–	–	5	**1**	10	–	7	–
96	Wellesley,	6,687	1	–	17	–	1	**1**	1	–	4	–	22	–
97	Franklin,	6,633	1	–	2	–	–	–	2	–	–	–	2	–
98	Ludlow,	6,566	3	**1**	4	–	2	–	67	**6**	–	–	211	–
99	Fairhaven,	6,556	3	**1**	4	–	–	–	3	**1**	–	–	7	–
100	Ipswich,	6,392	1	–	5	–	1	–	10	–	–	–	22	–
101	Grafton,	6,361	1	–	–	–	–	–	–	–	–	–	24	3
102	North Andover,	6,059	1	**1**	10	–	–	–	–	–	–	–	5	–
103	Westborough,	6,041	–	–	1	–	–	–	2	–	–	–	12	–

to the Public Health, 1916 — Continued.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28–29 Tuberculosis, Pulmonary.		30–35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		14 Dysentery.		4 Malaria.		100 Septic Sore Throat.		75A Trachoma.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
3	–	7	–	11	1	21	10	–	2	14	1	101	4	–	–	–	–	–	1	–	–	44
–	–	9	–	45	1	20	10	1	5	14	2	5	1	–	–	–	–	–	–	–	–	45
1	–	2	–	46	–	11	13	–	2	7	–	12	3	–	–	–	–	–	–	1	–	46
150	–	–	–	41	–	21	9	1	1	–	1	66	1	–	–	–	–	–	1	–	–	47
13	–	2	–	35	–	20	18	1	2	6	–	24	–	–	–	–	–	–	–	–	–	48
3	–	1	–	30	–	20	15	1	2	5	–	6	–	–	–	–	–	1	1	–	–	49
2	–	4	–	16	–	19	6	2	4	5	–	18	1	–	–	–	–	3	–	–	–	50
–	–	–	–	29	–	15	21	–	4	6	2	–	2	–	2	–	–	–	–	–	–	51
–	–	1	–	3	–	20	5	–	1	1	–	3	2	–	–	–	–	–	1	–	–	52
–	–	–	–	8	–	19	9	–	1	2	–	–	1	–	–	–	–	–	–	–	–	53
–	–	4	–	23	–	16	14	–	–	3	–	59	–	–	5	–	–	–	–	–	–	54
2	–	6	–	13	–	18	5	–	–	–	–	45	2	–	–	–	–	1	–	–	–	55
–	–	2	–	9	–	7	8	1	3	12	–	7	–	–	–	–	–	–	–	–	–	56
–	–	–	–	35	–	21	13	2	1	1	–	73	3	1	1	–	–	–	–	–	–	57
–	–	14	–	57	–	6	6	–	1	1	1	29	2	–	–	–	–	2	–	–	–	58
–	–	3	–	9	1	1	6	–	6	5	3	–	–	–	–	–	–	–	–	–	–	59
–	–	1	–	24	–	16	9	–	6	3	–	7	–	–	–	–	–	–	–	–	–	60
8	–	8	–	14	–	17	11	2	5	6	–	2	1	–	–	–	–	–	–	1	–	61
2	–	2	–	13	–	4	4	–	4	2	–	–	1	–	–	–	–	–	–	–	–	62
8	–	3	–	79	–	16	6	2	3	2	–	24	2	–	–	–	–	1	–	–	–	63
3	–	2	–	9	–	17	22	1	4	3	–	32	–	–	–	–	–	–	–	–	–	64
1	–	1	–	.26	–	12	9	2	0	2	–	35	1	–	–	4	–	6	1	–	–	65
14	–	4	–	31	–	13	3	3	1	2	–	32	–	4	–	–	–	–	–	1	–	66
–	–	3	–	15	–	10	4	–	1	9	1	4	2	–	–	–	–	–	–	–	–	67
3	–	–	–	18	–	10	3	2	1	5	–	46	1	–	–	–	–	–	–	–	–	68
–	–	–	–	39	–	13	4	–	1	2	–	1	1	–	2	–	–	–	–	–	–	69
–	–	–	–	17	–	8	10	–	5	3	–	–	2	–	–	–	–	–	–	–	–	70
204	–	*121*	–	*591*	*6*	*375*	*302*	*41*	*42*	*116*	*11*	*952*	*26*	*1*	*7*	*12*	–	*21*	–	*3*	–	71
7	–	3	–	26	–	34	33	2	4	8	–	1	–	–	–	–	–	–	–	1	–	72
–	–	–	–	2	–	7	13	–	1	2	–	–	–	–	–	–	–	–	–	–	–	73
4	–	5	–	32	–	8	4	2	–	5	–	67	–	–	–	–	–	–	–	–	–	74
–	–	–	–	2	–	4	7	–	2	–	–	–	–	–	–	–	–	–	–	–	–	75
–	–	1	–	26	1	18	5	2	–	12	1	3	1	–	–	2	–	–	–	–	–	76
–	–	–	–	12	–	8	6	1	3	3	–	–	–	–	–	–	–	–	–	1	–	77
5	–	–	–	43	–	5	2	–	2	4	–	20	–	–	–	–	–	–	–	–	–	78
–	–	3	–	6	–	21	5	1	–	5	1	41	4	–	–	–	–	–	–	–	–	79
4	–	1	–	8	–	11	4	2	1	1	–	28	1	–	–	–	–	3	–	1	–	80
–	–	2	–	28	–	13	8	–	–	3	–	23	2	–	–	–	–	–	–	–	–	81
1	–	2	–	48	1	9	11	2	–	3	–	1	1	–	–	–	–	–	–	–	–	82
33	–	1	–	6	1	10	5	1	1	6	–	75	1	–	–	–	–	–	–	–	–	83
–	–	2	–	7	–	3	6	–	–	1	–	–	–	–	–	1	–	–	–	–	–	84
3	–	12	–	26	–	1	4	–	–	4	1	11	–	–	–	–	–	–	–	–	–	85
–	–	2	–	11	–	9	4	1	3	–	–	14	–	–	–	–	–	–	–	–	–	86
2	–	2	–	2	–	11	6	1	–	7	–	8	–	–	–	–	–	–	–	–	–	87
2	–	1	–	2	–	8	9	–	–	1	1	21	–	–	–	–	–	–	–	–	–	88
1	–	1	–	6	–	6	6	–	1	2	1	1	–	–	–	–	–	–	–	–	–	89
–	–	–	–	10	–	2	6	2	2	4	2	–	–	–	–	–	–	–	–	–	–	90
–	–	1	–	16	1	6	5	3	1	–	–	62	–	–	–	–	–	–	–	–	–	91
–	–	–	–	5	–	9	5	1	–	–	–	3	–	–	1	–	–	–	–	–	–	92
–	–	–	–	2	–	2	3	–	–	2	–	1	–	–	–	–	–	–	–	–	–	93
–	–	1	–	5	–	1	3	1	–	1	–	1	–	–	–	–	–	–	–	–	–	94
–	–	1	–	12	–	10	6	–	–	1	–	10	–	–	–	–	–	–	–	–	–	95
9	–	20	–	15	–	7	1	1	–	5	–	113	1	–	–	5	–	–	–	–	–	96
–	–	1	–	10	–	–	2	–	1	–	–	–	–	–	1	–	–	–	–	–	–	97
25	–	6	–	4	–	11	8	–	1	4	–	5	–	–	–	–	–	–	–	–	–	98
–	–	2	–	15	–	12	5	–	–	5	1	6	1	–	–	–	–	–	–	–	–	99
–	–	–	–	9	–	14	5	–	–	2	–	31	2	–	–	–	–	–	–	–	–	100
–	–	–	–	–	1	1	27	–	2	1	–	–	–	–	2	–	–	–	–	–	–	101
–	–	1	–	9	–	8	5	–	1	2	–	–	–	–	–	–	–	–	–	–	–	102
2	–	–	–	1	–	19	6	–	1	1	–	–	–	–	1	–	–	–	–	–	–	103

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1916.	63A Poliomyelitis.		19A Chicken Pox.		61A Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
104	Winchendon, ...	5,964	–	–	7	–	1	–	17	–	2	–	8	–
105	Mansfield, ...	5,914	1	–	22	–	–	–	4	–	3	–	181	–
106	Canton, ...	5,823	3	2	17	–	–	–	13	1	1	–	32	–
107	Spencer, ...	5,814	–	–	–	–	–	–	–	–	1	–	4	–
108	Blackstone, ...	5,699	3	1	–	–	–	1	6	2	–	–	–	–
109	Abington, ...	5,692	1	–	7	–	–	–	2	–	–	–	222	–
110	Lexington, ...	5,688	3	–	32	–	1	–	4	–	7	–	10	–
111	Amherst, ...	5,666	2	1	21	–	–	–	17	1	1	–	27	–
112	Walpole, ...	5,635	6	–	9	–	2	2	30	1	14	–	23	–
113	Tewksbury, ...	5,631	1	–	–	–	–	1	–	–	–	–	–	–
114	Dartmouth, ...	5,560	4	–	–	–	–	–	6	1	–	–	30	1
115	Wareham, ...	5,436	4	2	33	–	–	–	–	–	–	–	168	–
116	Millbury, ...	5,429	–	–	–	–	–	–	–	–	–	–	–	–
117	Orange, ...	5,402	–	–	–	–	–	–	7	1	2	–	3	–
118	Hingham, ...	5,336	2	–	20	–	1	–	–	–	3	–	7	–
119	South Hadley, ...	5,248	12	4	13	1	–	–	2	1	2	–	15	–
120	Chelmsford, ...	5,224	–	–	–	–	–	–	3	–	–	–	61	–
121	Barnstable, ...	5,073	2	1	34	–	–	–	6	–	6	–	10	–
122	Monson, ...	5,063	9	5	9	–	–	–	2	–	–	–	7	–
123	Easton, ...	5,046	2	–	–	–	–	–	–	–	–	–	7	–
124	Towns, 2,500–5,000.	*185,118*	*76*	*11*	*152*	–	*2*	*4*	*231*	*19*	*33*	–	*899*	*23*
125	Uxbridge, ...	4,981	2	–	3	–	–	–	13	1	–	–	10	1
126	Randolph, ...	4,839	–	1	1	–	–	–	13	1	–	–	31	1
127	Agawam, ...	4,810	2	1	–	–	–	1	27	2	–	–	1	1
128	Lee, ...	4,558	1	–	–	–	–	–	–	–	–	–	–	–
129	Dudley, ...	4,399	5	1	3	–	–	–	–	–	2	–	9	1
130	Rockport, ...	4,390	1	–	7	–	–	–	2	–	–	–	14	–
131	Warren, ...	4,287	5	–	–	–	–	–	4	1	1	–	71	2
132	Provincetown, ...	4,277	–	–	4	–	–	–	7	2	–	–	5	–
133	Templeton, ...	4,160	1	–	–	–	1	1	17	1	–	–	1	–
134	Dracut, ...	4,158	–	–	–	–	–	–	–	2	–	–	4	–
135	Falmouth, ...	4,104	–	–	–	–	–	–	1	–	–	–	–	–
136	Williamstown, ...	4,047	–	–	5	–	–	–	8	1	2	–	59	–
137	Dalton, ...	3,928	17	6	7	–	–	–	–	–	–	–	–	–
138	East Bridgewater, ...	3,768	3	–	1	–	–	–	3	–	–	–	60	–
139	Foxborough, ...	3,729	1	–	7	–	–	–	8	–	17	–	31	–
140	Medfield, ...	3,692	–	–	2	–	–	–	1	1	1	–	2	–
141	Hardwick, ...	3,613	1	–	–	–	–	–	1	2	–	–	56	–
142	Barre, ...	3,601	1	–	3	–	–	–	6	–	–	–	–	–
143	Somerset, ...	3,517	–	–	–	–	–	–	19	3	–	–	5	–
144	Oxford, ...	3,504	2	–	2	–	–	–	31	–	–	–	32	1
145	Auburn, ...	3,489	4	–	–	–	–	–	–	–	–	–	3	1
146	Billerica, ...	3,356	2	–	2	–	–	–	7	–	–	–	13	–
147	Leicester, ...	3,343	1	–	–	–	–	–	3	–	–	–	–	–
148	Westport, ...	3,342	1	–	3	–	–	–	3	–	–	–	4	–
149	Lenox, ...	3,286	–	–	–	–	–	–	–	–	–	–	–	–
150	Nantucket, ...	3,215	1	–	–	–	–	–	–	–	–	–	4	–
151	Manchester, ...	3,011	1	–	24	–	–	–	2	–	–	–	2	–
152	Shrewsbury, ...	2,999	–	–	–	–	–	–	–	–	–	–	–	–
153	Holbrook, ...	2,980	1	–	5	–	–	–	1	1	1	–	51	–
154	North Brookfield, ...	2,916	1	–	–	–	–	–	1	–	–	–	11	–
155	Medway, ...	2,882	2	–	4	–	–	–	–	1	–	–	4	–
156	Deerfield, ...	2,867	1	–	–	–	–	–	–	–	–	–	5	–
157	Pepperell, ...	2,866	–	–	1	–	–	–	2	–	–	–	2	–
158	West Bridgewater, ...	2,864	–	–	2	–	–	–	3	–	–	–	18	1
159	Seekonk, ...	2,857	–	–	–	–	–	–	2	–	–	–	–	2
160	Cohasset, ...	2,852	–	–	1	–	–	–	1	–	–	–	9	–
161	Westford, ...	2,841	2	1	1	–	–	–	–	–	4	–	12	–
162	Hadley, ...	2,827	4	–	–	–	–	1	1	–	–	–	3	–
163	Holliston, ...	2,807	–	–	12	–	–	–	–	–	–	–	4	–

to the Public Health, 1916 — Continued.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28–29 Tuberculosis, Pulmonary.		30–35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		14 Dysentery.		4 Malaria.		100 Septic Sore Throat.		75A Trachoma.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
3	–	1	–	10	–	9	5	2	1	1	1	4	–	–	–	–	–	–	–	–	–	104
–	–	9	–	14	–	5	2	1	1	–	–	119	–	–	–	2	–	–	–	–	–	105
42	–	3	–	5	–	8	6	11	4	4	–	14	–	–	–	–	–	–	–	–	–	106
–	–	–	–	2	–	–	6	–	1	–	–	14	2	–	–	–	–	–	–	–	–	107
–	–	–	–	4	–	2	6	–	3	1	–	–	1	–	–	–	–	–	–	–	–	108
8	–	3	–	6	–	5	3	–	–	–	–	14	–	–	–	–	–	–	–	–	–	109
4	–	–	–	25	–	10	7	2	1	–	1	80	1	1	2	–	–	–	–	–	–	110
1	–	5	–	16	–	7	2	–	–	–	–	63	–	–	–	–	–	2	–	–	–	111
10	–	–	–	9	–	1	3	1	–	1	–	55	2	–	–	1	–	–	–	–	–	112
–	–	1	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	113
27	–	1	–	7	–	5	2	1	–	1	1	–	–	–	–	–	–	–	–	–	–	114
–	–	4	–	18	–	7	3	–	2	–	–	3	2	–	–	–	–	–	–	–	–	115
–	–	–	–	1	–	1	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	116
–	–	–	–	25	–	–	3	–	2	4	–	5	–	–	–	–	–	–	–	–	–	117
–	–	2	–	7	–	8	2	–	–	1	–	6	–	–	–	–	–	–	–	–	–	118
–	–	2	–	24	–	2	3	–	–	1	–	4	–	–	–	–	–	–	–	–	–	119
–	–	–	–	3	1	1	3	–	–	2	–	–	–	–	–	–	–	–	–	–	–	120
11	–	19	–	2	–	5	5	–	–	3	–	11	2	–	–	1	–	16	–	–	–	121
–	–	–	–	7	–	10	4	–	–	–	–	9	–	–	–	–	–	–	–	–	–	122
–	–	–	–	–	–	–	3	–	–	2	–	5	2	–	–	–	–	–	–	–	–	123
64	–	*19*	–	*247*	*5*	*134*	*158*	*11*	*30*	*55*	*8*	*271*	*28*	–	*3*	*3*	–	–	*2*	*1*	–	124
1	–	–	–	4	–	4	2	–	1	3	–	–	–	–	–	3	–	–	–	–	–	125
–	–	–	–	1	–	1	4	–	1	1	–	1	–	–	–	–	–	–	–	–	–	126
–	–	–	–	1	–	1	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	127
–	–	–	–	–	–	1	–	1	–	4	–	–	–	–	–	–	–	–	–	–	–	128
–	–	1	–	1	–	–	1	–	–	1	1	27	1	–	1	–	–	–	–	–	–	129
–	–	–	–	14	–	2	1	2	–	1	–	1	–	–	–	–	–	–	–	–	–	130
–	–	–	–	19	–	1	1	1	2	–	–	–	–	–	–	–	–	–	1	–	–	131
–	–	–	–	–	–	1	2	–	1	6	–	7	–	–	–	–	–	–	–	–	–	132
–	–	1	–	11	1	–	2	–	–	2	2	–	–	–	–	–	–	–	–	–	–	133
–	–	–	–	1	–	–	4	–	2	–	–	–	–	–	–	–	–	–	–	–	–	134
–	–	–	–	–	–	2	3	–	–	–	–	–	1	–	–	–	–	–	–	–	–	135
–	–	–	–	3	–	6	5	–	–	–	–	–	1	–	–	–	–	–	–	–	–	136
1	–	–	–	11	–	–	1	–	–	–	–	11	–	–	–	–	–	–	–	–	–	137
–	–	–	–	4	–	42	12	–	4	2	–	1	–	–	–	–	–	–	–	–	–	138
–	–	1	–	10	–	2	8	–	–	1	–	18	–	–	–	–	–	–	–	–	–	139
–	–	–	–	–	–	8	19	–	5	3	1	–	–	–	–	–	–	–	–	–	–	140
–	–	–	–	16	–	4	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	141
1	–	1	–	7	–	–	1	–	–	–	–	15	3	–	–	–	–	–	–	–	–	142
–	–	–	–	5	1	6	3	–	–	1	–	–	1	–	–	–	–	–	–	–	–	143
–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	144
2	–	1	–	5	–	–	1	–	–	2	1	6	1	–	–	–	–	–	–	–	–	145
2	–	–	–	3	–	1	3	–	–	1	–	–	–	–	–	–	–	–	–	–	–	146
–	–	–	–	4	–	–	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	147
4	–	1	–	2	–	–	3	–	2	1	–	11	1	–	–	–	–	–	–	–	–	148
–	–	1	–	–	–	–	3	–	1	2	–	11	–	–	–	–	–	–	–	–	–	149
–	–	–	–	–	–	2	2	–	1	8	–	5	–	–	–	–	–	–	–	–	–	150
15	–	1	–	–	–	2	1	1	–	–	–	16	–	–	–	–	–	–	–	–	–	151
–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	152
–	–	1	–	–	–	1	–	–	–	–	–	6	1	–	–	–	–	–	–	–	–	153
–	–	–	–	9	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	154
–	–	–	–	3	–	–	5	–	–	–	–	–	–	–	1	–	–	–	–	–	–	155
–	–	–	–	2	–	–	2	–	–	–	–	2	–	–	–	–	–	–	–	–	–	156
–	–	–	–	7	1	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	157
–	–	–	–	1	–	1	5	–	–	5	–	–	1	–	–	–	–	–	–	–	–	158
–	–	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	159
–	–	–	–	11	–	2	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	160
2	–	–	–	3	1	2	3	1	1	2	1	35	2	–	–	–	–	–	–	–	–	161
1	–	–	–	6	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	162
–	–	–	–	3	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	163

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1916.	63A Poliomyelitis.		19A Chicken Pox.		61A Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
164	Hatfield,	2,786	2	–	5	–	–	–	3	–	1	–	14	1
165	Ayer,	2,775	–	–	3	–	–	–	–	–	2	–	91	1
166	Sutton,	2,769	–	–	6	–	–	–	1	–	–	–	16	–
167	Hopedale,	2,760	1	–	–	–	–	–	1	–	1	–	4	–
168	Hanover,	2,748	–	–	1	–	–	–	–	–	–	–	23	–
169	Bourne,	2,720	5	–	5	–	–	–	–	–	–	–	26	2
170	Scituate,	2,705	–	–	2	–	–	–	4	–	–	–	7	–
171	Swansea,	2,698	1	1	–	–	–	–	5	–	–	–	4	–
172	Lancaster,	2,614	–	–	5	–	–	–	–	–	–	–	8	–
173	Kingston,	2,613	–	–	1	–	–	–	2	–	–	–	25	–
174	Holden,	2,603	–	–	4	–	1	1	1	–	–	–	19	–
175	Norton,	2,598	–	–	–	–	–	–	1	–	–	–	31	1
176	Wrentham,	2,576	1	–	17	–	–	–	18	–	1	–	65	6
177	Wilbraham,	2,567	2	–	–	–	–	–	4	–	–	–	24	1
178	Dighton,	2,563	–	–	1	–	–	–	2	–	–	–	–	–
179	Acushnet,	2,555	–	–	1	–	–	–	–	–	–	–	–	–
180	Sharon,	2,506	1	–	1	–	–	–	2	–	–	–	6	–
181	Towns under 2,500.	*209,341*	*94*	*22*	*162*	*1*	*5*	*2*	*160*	*13*	*41*	–	*1,718*	*4*
182	Hopkinton,	2,480	2	1	–	–	–	–	–	–	13	–	8	–
183	Wilmington,	2,444	1	–	8	–	1	–	–	–	–	–	17	–
184	Groveland,	2,407	–	–	–	–	–	–	4	–	–	–	38	–
185	Weston,	2,399	2	–	21	–	–	–	13	–	–	–	8	–
186	Groton,	2,376	–	–	–	–	–	–	–	–	–	–	–	–
187	Hull,	2,335	1	–	6	–	2	1	1	–	1	–	7	–
188	Rehoboth,	2,283	–	–	–	–	–	–	1	–	–	–	4	–
189	Shirley,	2,278	–	–	–	–	–	–	8	–	–	–	105	–
190	Charlton,	2,257	2	–	–	–	–	–	1	–	–	–	7	–
191	Avon,	2,200	–	–	4	–	–	–	1	–	–	–	68	–
192	Harwich,	2,194	–	–	–	–	–	–	2	–	–	–	19	–
193	Douglas,	2,186	1	–	1	–	–	–	6	1	–	–	47	–
194	Acton,	2,155	1	–	5	–	–	–	–	–	3	–	6	–
195	Williamsburg,	2,115	1	1	–	–	–	–	–	–	–	–	37	3
196	Ashland,	2,083	–	–	3	–	–	–	–	–	–	–	4	–
197	Georgetown,	2,082	1	1	–	–	–	–	6	–	–	–	–	–
198	Merrimac,	2,077	1	–	–	–	–	–	–	–	–	–	1	–
199	Belchertown,	2,064	2	1	1	–	–	–	–	–	–	–	19	–
200	Ashburnham,	2,047	–	–	2	–	–	–	3	1	–	–	1	–
201	East Longmeadow,	2,032	3	1	–	–	–	–	–	–	–	–	41	–
202	Upton,	2,028	–	–	–	–	–	–	–	–	–	–	1	–
203	Brookfield,	2,024	–	–	8	–	–	–	1	–	–	–	14	–
204	Bellingham,	2,015	–	–	–	–	–	–	7	2	–	–	7	–
205	Wayland,	1,991	–	–	–	–	–	–	1	–	–	–	–	–
206	Duxbury,	1,977	–	–	5	–	–	–	2	–	–	–	50	–
207	Southborough,	1,935	–	–	–	–	–	–	2	–	1	–	2	–
208	Rutland,	1,932	–	–	–	–	–	–	–	–	–	–	3	–
209	Hamilton,	1,910	4	2	1	–	–	–	4	1	–	–	1	–
210	Stockbridge,	1,893	1	–	–	–	–	–	1	–	–	–	38	–
211	Sheffield,	1,873	1	1	–	–	–	–	2	–	–	–	9	–
212	Colrain,	1,850	–	–	–	–	–	–	1	–	–	–	–	–
213	Raynham,	1,831	1	–	2	–	–	–	–	–	–	–	7	–
214	Townsend,	1,824	1	–	–	–	–	–	–	–	–	–	28	–
215	Northborough,	1,817	1	–	2	–	–	–	–	–	–	–	13	–
216	Northfield,	1,816	–	–	2	–	–	–	–	–	–	–	10	–
217	Longmeadow,	1,806	1	–	1	–	–	–	6	–	–	–	31	–
218	Dennis,	1,799	1	–	–	–	–	–	1	–	–	–	79	–
219	Hanson,	1,782	–	–	–	–	–	–	1	–	–	–	44	–
220	Sherborn,	1,761	–	–	14	–	–	–	–	–	–	–	–	–
221	Salisbury,	1,731	2	1	–	–	–	–	–	–	1	–	41	–
222	Marshfield,	1,722	–	–	1	–	–	–	–	–	–	–	63	–
223	Carver,	1,710	–	–	–	–	–	–	–	–	–	–	23	–

to the Public Health, 1916 — Continued.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28–29 Tuberculosis, Pulmonary.		30–35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		14 Dysentery.		4 Malaria.		100 Septic Sore Throat.		75A Trachoma.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
1	–	2	–	7	–	4	1	1	1	1	–	3	5	–	–	–	–	–	1	–	–	164
1	–	–	–	9	–	4	5	–	–	–	–	3	–	–	–	–	–	–	–	–	–	165
–	–	2	–	1	–	1	1	–	–	–	–	8	–	–	1	–	–	–	–	–	–	166
8	–	–	–	–	–	4	1	–	–	–	–	31	–	–	–	–	–	–	–	–	–	167
–	–	2	–	–	–	1	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	168
1	–	–	–	3	–	–	1	1	–	–	–	17	1	–	–	–	–	–	–	–	–	169
–	–	–	–	9	–	1	1	–	1	2	–	5	–	–	–	–	–	–	–	–	–	170
–	–	–	–	2	–	–	1	–	–	1	–	2	1	–	–	–	–	–	–	–	–	171
1	–	–	–	10	–	1	1	1	–	–	–	4	–	–	–	–	–	–	–	1	–	172
–	–	–	–	–	–	1	4	–	1	1	1	1	–	–	–	–	–	–	–	–	–	173
1	–	–	–	6	–	8	3	1	–	2	–	4	–	–	–	–	–	–	–	–	–	174
–	–	1	–	3	–	2	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	175
15	–	–	–	8	–	3	7	–	2	–	–	1	–	–	–	–	–	–	–	–	–	176
2	–	1	–	9	–	1	2	–	1	–	–	2	2	–	–	–	–	–	–	–	–	177
–	–	–	–	9	–	1	2	–	–	1	1	–	3	–	–	–	–	–	–	–	–	178
1	–	2	–	1	–	2	3	–	–	–	–	3	–	–	–	–	–	–	–	–	–	179
4	–	–	–	–	–	5	3	1	–	–	–	14	–	–	–	–	–	–	–	–	–	180
84	–	*18*	–	*270*	*3*	*99*	*355*	*5*	*28*	*48*	*5*	*378*	*17*	–	*5*	–	–	*13*	–	*1*	–	181
–	–	–	–	4	–	1	3	1	2	–	–	2	–	–	–	–	–	–	–	–	–	182
–	–	1	–	4	–	–	3	–	–	–	–	8	–	–	–	–	–	–	–	–	–	183
–	–	–	–	5	–	1	2	–	–	1	–	–	–	–	–	–	–	1	–	–	–	184
1	–	–	–	2	–	4	–	–	–	1	–	11	–	–	–	–	–	–	–	–	–	185
–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	186
2	–	1	–	8	–	–	2	–	–	–	–	28	–	–	–	–	–	–	–	–	–	187
–	–	–	–	–	–	2	5	–	–	–	–	24	–	–	–	–	–	–	–	–	–	188
–	–	–	–	1	–	1	–	–	–	1	–	2	–	–	–	–	–	–	–	–	–	189
–	–	–	–	3	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	190
–	–	–	–	5	–	2	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	191
–	–	1	–	–	–	–	2	–	–	1	–	5	2	–	–	–	–	–	–	–	–	192
–	–	–	–	4	–	4	4	–	–	–	–	10	1	–	1	–	–	–	–	–	–	193
–	–	–	–	2	–	2	1	–	–	–	–	34	1	–	–	–	–	–	–	–	–	194
–	–	–	–	1	–	8	1	–	–	2	–	–	–	–	–	–	–	1	–	–	–	195
1	–	–	–	10	–	4	3	–	–	–	–	5	–	–	–	–	–	–	–	–	–	196
–	–	2	–	9	–	1	1	–	–	2	–	2	–	–	–	–	–	1	–	–	–	197
–	–	–	–	6	1	–	1	–	–	–	–	2	1	–	–	–	–	–	–	–	–	198
–	–	–	–	1	–	–	1	–	1	–	–	1	–	–	–	–	–	–	–	–	–	199
–	–	–	–	–	–	2	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	200
–	–	–	–	15	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	201
–	–	–	–	1	–	1	2	–	1	–	1	–	–	–	–	–	–	–	–	–	–	202
–	–	–	–	2	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	203
–	–	–	–	4	–	–	5	–	–	1	–	3	1	–	–	–	–	–	–	–	–	204
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	205
–	–	–	–	1	–	2	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	206
2	–	–	–	8	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	207
–	–	–	–	–	–	–	52	–	3	–	–	–	–	–	–	–	–	–	–	–	–	208
–	–	–	–	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	209
–	–	–	–	–	–	3	2	–	1	–	–	–	–	–	1	–	–	–	–	–	–	210
–	–	–	–	–	–	1	–	–	–	–	–	102	2	–	–	–	–	–	–	–	–	211
–	–	–	–	–	–	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	212
–	–	–	–	1	–	–	3	–	–	–	–	–	1	–	–	–	–	–	–	–	–	213
–	–	–	–	1	–	1	2	–	–	–	–	13	–	–	–	–	–	–	–	–	–	214
10	–	–	–	6	–	1	1	–	1	–	–	6	–	–	–	–	–	3	–	–	–	215
1	–	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	216
2	–	–	–	2	–	1	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	217
–	–	–	–	–	–	1	3	–	–	3	–	13	–	–	1	–	–	–	–	–	–	218
–	–	–	–	1	–	1	1	–	1	1	–	–	–	–	–	–	–	–	–	1	–	219
1	–	–	–	–	–	–	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	220
–	–	1	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	221
3	–	–	–	–	–	1	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	222
–	–	–	–	–	–	3	1	–	–	1	–	3	–	–	–	–	–	–	–	–	–	223

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1916.	63A Poliomyelitis.		19A Chicken Pox.		61A Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
224	Freetown,	1,709	–	–	–	–	–	–	2	–	–	–	1	–
225	Chatham,	1,692	–	–	–	–	–	–	10	2	–	–	75	–
226	Essex,	1,691	–	–	1	–	–	–	3	–	–	–	17	1
227	Lunenburg,	1,662	1	–	1	–	–	–	11	1	–	–	12	–
228	Westminster,	1,652	1	1	–	–	–	–	–	–	–	–	4	–
229	Newbury,	1,616	3	2	–	–	–	1	3	–	–	–	2	–
230	Norwell,	1,600	–	–	1	–	–	–	–	–	–	–	–	–
231	Lakeville,	1,575	–	–	–	–	–	–	1	1	–	–	6	–
232	Buckland,	1,568	–	–	–	–	–	–	–	–	–	–	1	–
233	Cheshire,	1,545	1	–	–	–	–	–	1	–	–	–	–	–
234	West Newbury,	1,543	9	1	2	–	–	–	2	–	–	–	3	–
235	Sturbridge,	1,536	1	–	–	–	–	–	10	2	–	–	–	–
236	Rowley,	1,508	–	–	–	–	–	–	–	–	–	–	7	–
237	Marion,	1,493	–	–	2	–	–	–	1	–	–	–	2	–
238	Westwood,	1,492	1	–	–	–	–	–	4	–	–	–	–	–
239	Shelburne,	1,480	–	–	–	–	–	–	2	–	–	–	–	–
240	Sandwich,	1,454	1	–	1	1	–	–	–	–	1	–	–	–
241	Millis,	1,452	–	–	1	–	–	–	–	–	–	–	–	–
242	Southwick,	1,448	2	1	–	–	–	–	–	–	–	–	–	–
243	Nahant,	1,436	3	–	–	–	–	–	1	–	–	–	–	–
244	Huntington,	1,416	–	–	–	–	–	–	–	–	–	–	–	–
245	Plainville,	1,414	1	–	–	–	–	–	2	–	–	–	19	–
246	Sterling,	1,414	–	–	–	–	–	–	–	–	–	–	1	–
247	Yarmouth,	1,414	1	–	–	–	–	–	–	–	–	–	105	–
248	Bedford,	1,397	–	–	2	–	1	–	–	–	–	–	7	–
249	Mattapoisett,	1,381	–	–	13	–	1	–	1	–	–	–	5	–
250	Tisbury,	1,355	2	1	–	–	–	–	1	–	–	–	1	–
251	Middleton,	1,351	1	1	–	–	–	–	–	–	–	–	4	–
252	North Reading,	1,348	2	–	–	–	–	–	–	–	–	–	–	–
253	Lincoln,	1,343	–	–	3	–	–	–	1	–	–	–	–	–
254	Norfolk,	1,342	–	–	–	–	–	–	–	–	–	–	–	–
255	Pembroke,	1,337	–	–	–	–	–	–	1	–	–	–	3	–
256	Chester,	1,336	–	–	–	–	–	–	2	–	–	–	–	–
257	Sunderland,	1,334	–	–	–	–	–	–	1	–	–	–	7	–
258	West Boylston,	1,330	1	–	–	–	–	–	1	–	2	–	18	–
259	Edgartown,	1,297	–	–	–	–	–	–	5	–	1	–	–	–
260	Hinsdale,	1,291	–	–	–	–	–	–	–	–	–	–	–	–
261	Oak Bluffs,	1,284	–	–	–	–	–	–	–	–	–	–	–	–
262	West Brookfield,	1,279	–	–	–	–	–	–	–	–	–	–	9	–
263	West Stockbridge,	1,278	–	–	–	–	–	–	–	–	–	–	1	–
264	Littleton,	1,228	1	1	–	–	–	–	–	–	–	–	2	–
265	Sudbury,	1,227	–	–	–	–	–	–	2	–	–	–	3	–
266	Conway,	1,218	5	1	1	–	–	–	–	–	–	–	–	–
267	Orleans,	1,188	1	–	5	–	–	–	–	–	–	–	1	–
268	Whately,	1,184	1	1	–	–	–	–	–	–	–	–	–	–
269	Rochester,	1,177	–	–	1	–	–	–	–	–	–	–	4	–
270	Erving,	1,173	3	–	1	–	–	–	–	–	–	–	41	–
271	Topsfield,	1,173	–	–	–	–	–	–	–	–	–	–	39	–
272	Lynnfield,	1,161	–	–	–	–	–	–	–	–	–	–	–	–
273	Russell,	1,138	–	–	–	–	–	–	–	–	–	–	–	–
274	Stow,	1,130	–	–	1	–	–	–	–	–	–	–	11	–
275	Lanesborough,	1,123	–	–	–	–	–	–	–	–	–	–	3	–
276	Harvard,	1,121	1	–	1	–	–	–	–	–	–	–	3	–
277	Clarksburg,	1,092	–	–	–	–	–	–	–	–	–	–	9	–
278	Hubbardston,	1,087	–	–	–	–	–	–	–	–	–	–	10	–
279	Wenham,	1,082	1	–	–	–	–	–	–	–	–	–	–	–
280	Dover,	1,048	1	–	6	–	–	–	–	–	–	–	3	–
281	New Marlborough,	1,007	1	–	–	–	–	–	–	–	–	–	23	–
282	Ashfield,	1,002	–	–	–	–	–	–	–	–	–	–	–	–
283	Tyngsborough,	1,000	–	–	–	–	–	–	2	–	10	–	48	–
284	Berkley,	982	–	–	–	–	–	–	–	–	–	–	8	–
285	Becket,	976	–	–	5	–	–	–	–	–	–	–	3	–
286	Charlemont,	971	–	–	–	–	–	–	1	–	–	–	5	–

to the Public Health, 1916 — Continued.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28–29 Tuberculosis, Pulmonary.		30–35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		14 Dysentery.		4 Malaria.		100 Septic Sore Throat.		75A Trachoma.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	–	1	–	–	–	224
–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	225
–	–	–	–	6	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	226
1	–	2	–	–	–	2	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	227
1	–	–	–	–	–	2	2	–	–	1	–	3	1	–	–	–	–	–	–	–	–	228
–	–	–	–	2	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	229
–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	230
–	–	–	–	–	–	1	101	–	1	1	–	1	–	–	–	–	–	–	–	–	–	231
–	–	–	–	3	–	–	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	232
–	–	–	–	1	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	233
–	–	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	234
–	–	–	–	3	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	235
–	–	–	–	4	–	1	1	1	–	6	–	–	–	–	–	–	–	–	–	–	–	236
–	–	–	–	15	–	2	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	237
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	238
–	–	–	–	1	–	–	2	–	–	1	1	–	–	–	–	–	–	–	–	–	–	239
–	–	–	–	–	–	5	2	1	–	1	–	–	–	–	–	–	–	–	–	–	–	240
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	241
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	242
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	243
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	244
–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	245
–	–	–	–	1	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	246
–	–	3	–	1	–	1	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	247
–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	248
2	–	–	–	1	–	–	1	–	–	–	–	8	–	–	–	–	–	–	–	–	–	249
2	–	1	–	–	–	1	1	–	1	–	–	1	–	–	–	–	–	–	–	–	–	250
–	–	–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	251
–	–	–	–	4	–	–	54	–	–	–	–	–	–	–	–	–	–	–	–	–	–	252
–	–	–	–	5	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	253
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	254
–	–	–	–	–	–	1	2	–	3	–	–	–	–	–	–	–	–	–	–	–	–	255
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	256
–	–	–	–	8	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	257
–	–	–	–	3	–	2	1	–	–	1	–	5	–	–	–	–	–	–	–	–	–	258
4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	259
–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	260
22	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	261
–	–	–	–	3	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	262
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	263
1	–	–	–	2	–	–	2	–	–	–	–	–	–	–	–	–	–	1	–	–	–	264
–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	265
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	266
–	–	–	–	–	–	–	–	–	–	1	–	2	–	–	–	–	–	–	–	–	–	267
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	268
3	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	269
1	–	1	–	8	–	1	1	–	–	1	–	3	–	–	–	–	–	–	–	–	–	270
–	–	–	–	3	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	271
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	272
–	–	–	–	3	–	1	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	273
–	–	–	–	5	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	274
–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	275
–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	276
–	–	–	–	3	–	3	2	–	–	2	–	–	–	–	–	–	–	–	–	–	–	277
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	278
–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	279
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	280
–	–	–	–	5	–	–	–	–	–	–	–	33	1	–	–	–	–	–	–	–	–	281
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	282
–	–	–	–	5	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	283
–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	284
–	–	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	285
1	–	1	–	2	2	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	286

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1916.	63A Poliomyelitis.		19A Chicken Pox.		61A Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
287	Southampton,	969	1	–	–	–	–	–	–	–	–	–	1	–
288	Gill,	953	–	–	6	–	–	–	1	–	4	–	–	–
289	Mendon,	946	–	–	–	–	–	–	6	–	–	–	54	–
290	Brimfield,	940	–	–	–	–	–	–	1	–	–	–	25	–
291	Ashby,	931	–	–	–	–	–	–	–	–	–	–	1	–
292	Wellfleet,	915	–	–	–	–	–	–	–	–	–	–	1	–
293	Royalston,	879	–	–	–	–	–	–	–	–	–	–	–	–
294	Berlin,	854	–	–	–	–	–	–	–	–	–	–	3	–
295	Granby,	844	–	–	–	–	–	–	–	–	–	–	–	–
296	Brewster,	820	–	–	–	–	–	–	–	–	–	–	1	–
297	Bernardston,	802	1	–	–	–	–	–	–	–	–	–	–	–
298	Boylston,	800	–	–	–	–	–	–	1	–	–	–	1	–
299	Princeton,	796	1	–	–	–	–	–	–	–	–	–	3	–
300	Leverett,	791	–	–	–	–	–	–	–	–	–	–	–	–
301	Burlington,	790	–	–	–	–	–	–	1	–	–	–	–	–
302	Enfield,	790	1	–	–	–	–	–	–	–	–	–	2	–
303	Granville,	785	–	–	–	–	–	–	–	–	–	–	–	–
304	Bolton,	769	–	–	1	–	–	–	–	–	–	–	26	–
305	Petersham,	720	–	–	–	–	–	–	–	–	–	–	–	–
306	Boxford,	713	2	1	–	–	–	–	–	–	–	–	15	–
307	Dana,	706	–	–	8	–	–	–	–	–	–	–	1	–
308	Hampden,	676	–	–	–	–	–	–	–	–	–	–	29	–
309	Cummington,	666	–	–	–	–	–	–	–	–	–	–	–	–
310	Truro,	665	–	–	–	–	–	–	–	–	–	–	1	–
311	Halifax,	659	1	–	–	–	–	–	–	–	–	–	11	–
312	Worthington,	630	1	–	–	–	–	–	–	–	–	–	4	–
313	New Salem,	622	–	–	–	–	–	–	–	–	–	–	–	–
314	Plympton,	608	1	–	–	–	–	–	–	–	–	–	2	–
315	Blandford,	600	–	–	4	–	–	–	–	–	–	–	–	–
316	Egremont,	598	1	–	–	–	–	–	–	–	–	–	–	–
317	Chesterfield,	565	–	–	–	–	–	–	–	–	–	–	18	–
318	Sandisfield,	564	–	–	–	–	–	–	–	–	–	–	–	–
319	Eastham,	552	–	–	3	–	–	–	–	–	–	–	56	–
320	Richmond,	543	–	–	–	–	–	–	–	–	–	–	–	–
321	Savoy,	530	1	–	–	–	–	–	–	–	–	–	4	–
322	Hancock,	526	–	–	1	–	–	–	–	–	–	–	–	–
323	Oakham,	521	–	–	–	–	–	–	–	–	–	–	6	–
324	Pelham,	507	–	–	–	–	–	–	–	–	–	–	–	–
325	Paxton,	484	–	–	–	–	–	–	–	–	–	–	–	–
326	Warwick,	477	1	1	–	–	–	–	–	–	–	–	1	–
327	Carlisle,	475	–	–	–	–	–	–	–	–	1	–	–	–
328	New Braintree,	450	–	–	–	–	–	–	–	–	–	–	2	–
329	West Tisbury,	442	–	–	–	–	–	–	–	–	1	–	6	–
330	Florida,	435	–	–	–	–	–	–	–	–	–	–	–	–
331	Westhampton,	432	1	–	–	–	–	–	–	–	–	–	–	–
332	Otis,	430	1	–	–	–	–	–	–	–	–	–	–	–
333	Hawley,	428	1	–	–	–	–	–	–	–	–	–	2	–
334	Greenwich,	420	–	–	–	–	–	–	–	–	–	–	2	–
335	Rowe,	416	–	–	–	–	–	–	–	–	–	–	–	–
336	Heath,	392	–	–	–	–	–	–	–	–	–	–	8	–
337	Phillipston,	381	–	–	–	–	–	–	–	–	–	–	–	–
338	Plainfield,	368	–	–	–	–	–	–	–	–	–	–	1	–
339	Windsor,	368	–	–	–	–	–	–	–	–	–	–	–	–
340	Wendell,	361	–	–	–	–	–	–	–	–	–	–	–	–
341	Dunstable,	351	–	–	–	–	–	–	–	–	–	–	1	–
342	Monterey,	351	–	–	–	–	–	–	–	–	–	–	–	–
343	Leyden,	349	–	–	–	–	–	–	1	–	–	–	–	–
344	Wales,	335	–	–	–	–	–	–	1	1	–	–	–	–
345	Boxborough,	328	–	–	4	–	–	–	–	–	–	–	–	–
346	Middlefield,	318	–	–	–	–	–	–	–	–	–	–	–	–
347	Tyringham,	315	–	–	–	–	–	–	–	–	–	–	–	–
348	Monroe,	308	–	–	–	–	–	–	–	–	–	–	2	–
349	Shutesbury,	298	–	–	–	–	–	–	–	–	–	–	–	–

to the Public Health, 1916 — Continued.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28–29 Tuberculosis, Pulmonary.		30–35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		14 Dysentery.		4 Malaria.		100 Septic Sore Throat.		75A Trachoma.		
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Line No.
–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	287
1	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	288
–	–	–	–	11	–	1	1	–	–	–	–	2	–	–	–	–	–	–	–	–	–	289
–	–	–	–	3	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	290
–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	291
–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	292
–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	293
–	–	–	–	1	–	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	294
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	295
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	296
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	297
–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	298
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	299
–	–	–	–	1	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	300
–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	301
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	302
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	303
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	304
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	305
–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	306
–	–	1	–	5	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	307
–	–	–	–	3	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	308
–	–	–	–	–	–	1	1	–	–	1	–	4	–	–	–	–	–	–	–	–	–	309
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	310
–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	311
3	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	312
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	313
–	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	314
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	315
–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	316
16	–	–	–	1	–	1	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	317
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	318
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	319
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	320
–	–	–	–	1	–	–	–	–	–	2	1	–	–	–	–	–	–	–	–	–	–	321
–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	322
–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	323
–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	324
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	325
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	326
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	327
–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	328
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	329
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	330
–	–	–	–	6	–	–	–	–	–	–	–	3	1	–	–	–	–	–	–	–	–	331
–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	332
–	–	2	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	333
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	334
–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	335
–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	336
–	–	–	–	–	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	337
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	338
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2	–	–	–	3	–	–	–	–	–	2	1	–	–	–	–	–	–	–	–	–	–	340
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	341
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	343
–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	344
1	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	345
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–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	348
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	349

Cases and Deaths from Diseases Dangerous

Line No.	Cities and Towns grouped in Order of Population.	Population estimated as of July 1, 1916.	63A Poliomyelitis.		19A Chicken Pox.		61A Cerebrospinal Meningitis.		9 Diphtheria.		19B German Measles.		6 Measles.	
			Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
350	Prescott,	294	–	–	–	–	–	–	–	–	–	–	–	–
351	Chilmark,	290	–	–	–	–	–	–	–	–	2	–	–	–
352	Goshen,	290	–	–	–	–	–	–	–	–	–	–	–	–
353	Washington,	275	–	–	–	–	–	–	–	–	–	–	–	–
354	Alford,	270	–	–	–	–	–	–	–	–	–	–	–	–
355	Mashpee,	262	1	1	–	–	–	–	–	–	–	–	–	–
356	Montgomery,	233	–	–	–	–	–	–	–	–	–	–	–	–
357	Tolland,	204	–	–	–	–	–	–	1	1	–	–	–	–
358	Peru,	185	–	–	–	–	–	–	–	–	–	–	–	–
359	Gay Head,	178	–	–	–	–	–	–	–	–	–	–	–	–
360	Holland,	162	–	–	–	–	–	–	1	–	–	–	1	–
361	Gosnold,	156	–	–	–	–	–	–	–	–	–	–	–	–
362	New Ashford,	92	–	–	–	–	–	–	–	–	–	–	–	–
363	Mount Washington,	91	1	–	–	–	–	–	–	–	–	–	–	–
364	STATE INFIRMARY,	. .	–	–	60	–	–	1	33	2	–	–	3	–

In addition to the above there occurred 4 cases of actinomycosis: —

	Cases.	Deaths.
Boston,	1	–
Lowell,	1	–
New Bedford,	1	–
Winchendon,	1	–

31 cases of anthrax, with 5 deaths: —

	Cases.	Deaths.
Boston,	2	4
Chelsea,	1	–
Clinton,	1	–
Dartmouth,	1	–
New Bedford,	1	–
North Adams,	1	1
Norwood,	1	–
Peabody,	2	–
Salem,	1	–
Somerville,	1	–
Winchester,	6	–
Woburn,	12	–
Worcester,	1	–

71 cases of dog bite (requiring antirabic treatment). On final investigation 24 of these proved to have been bitten by rabid dogs.

	Cases.	Deaths.
Attleboro,	13	–
Beverly,	1	–
Boston,	9	–
Brockton,	6	–
Cambridge,	1	–
Chelsea,	2	–
Clinton,	1	–
Fall River,	1	–
Framingham,	1	–
Great Barrington,	1	–
Hudson,	3	–
Hull,	3	–
Lawrence,	8	–
Lowell,	12	–
Medford,	3	–
Millbury,	1	–
Montague,	1	–
Needham,	1	–
North Attleborough,	1	–
Walpole,	1	–
Worcester,	1	–

2 cases of leprosy, with 2 deaths: —

	Cases.	Deaths.
Boston,	1	–
Gosnold,	–	2
Woburn,	1	–

47 cases of pellagra, with 37 deaths: —

	Cases.	Deaths.
Arlington,	–	1
Boston,	10	8
Cambridge,	2	1
Danvers,	5	7

to the Public Health, 1916 — Concluded.

19C Mumps.		38A Ophthalmia Neonatorum.		7 Scarlet Fever.		28–29 Tuberculosis, Pulmonary.		30–35 Tuberculosis, Other Forms.		1 Typhoid Fever.		8 Whooping Cough.		14 Dysentery.		4 Malaria.		100 Septic Sore Throat.		75A Trachoma.		Line No.
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	350
–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	351
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	352
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–	–	–	–	2	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	355
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	359
–	–	1	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	360
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	361
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	362
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	363
46	–	4	–	–	–	498	297	2	14	3	–	10	–	–	–	1	–	–	–	–	–	364

	Cases.	Deaths.
Leominster,	1	–
Lynn,	1	–
Medfield,	–	1
Monson,	1	1
Newton,	1	–
Northampton,	3	3
Peabody,	1	–
Springfield,	1	1
State Infirmary,	4	3
Taunton,	2	–
Waltham,	1	1
Westborough,	1	3
Whitman,	1	–
Winchester,	1	1
Woburn,	11	6

32 cases of smallpox: —

Boston,	1	–
Chicopee,	1	–
Fitchburg,	11	–
Great Barrington,	4	–
Lee,	14	–
Lowell,	1	–

34 cases of tetanus, with 31 deaths: —

Adams,	1	–
Beverly,	–	1
Boston,	6	10
Concord,	1	–

	Cases.	Deaths.
Dartmouth,	2	–
Fall River,	2	3
Fitchburg,	1	–
Haverhill,	–	1
Lawrence,	2	–
Lowell,	3	3
Malden,	1	1
Marlborough,	1	1
Milford,	–	2
Nantucket,	1	1
Natick,	1	1
North Adams,	1	1
Pittsfield,	–	2
Salem,	1	–
Shelburne,	1	1
Springfield,	1	1
Wakefield,	1	–
Weymouth,	2	–
Woburn,	1	1
Worcester,	4	1

24 cases of trichinosis, with 3 deaths: —

Boston,	2	2
Brockton,	1	–
Chelsea,	2	–
Haverhill,	1	–
Lynn,	1	–
Newton,	1	–
Springfield,	13	–
Worcester,	3	1

DIVISION OF BIOLOGIC LABORATORIES.

DIVISION OF BIOLOGIC LABORATORIES.

REPORT ON THE PRODUCTION AND DISTRIBUTION OF VACCINE VIRUS.

ARTHUR L. REAGH, M.D., ASSISTANT.

During the past year no radical changes have been made in the methods employed in the vaccine work, but it will be noticed that the number of calves used during this period is nearly 50 per cent. less than in previous years. This economy was made possible by the following facts: —

1. There was on hand at the beginning of the year a larger supply of vaccine than usual.
2. Owing to the new practice of storing the vaccine always at a temperature below freezing, none had to be discarded for low potency due to ageing.
3. The average yield of vaccine per calf, approximately 97 cubic centimeters, is higher than formerly.

The only modification in technique to be noted is the special method of keeping the vaccinated area protected during the entire course of development of the eruption. To this end, a sling with attachments suggested by Dr. Rosenau was used to prevent the calf from lying down. The sling proper consists of a stout canvas band, 18 inches long, which passes under the thorax of the animal and is kept from slipping backwards by the front legs passing through holes in the canvas. Buckled to the sling is a canvas "breeching" 5 inches wide, passing backwards, and snugly around the buttocks. This is held in position from above by a strap passing over the back from below by cords on each side attached to the hind legs. No leather is used in the construction of this apparatus, which makes autoclaving possible.

Immediately after vaccination, and before the animal has a chance to lie down, the sterile sling is adjusted and hung by a single rope to an iron frame over the stall. The calf is thus supported while standing, is free to move and feed, but is restrained from lying down. The tail is attached, movably, to a cord at the side, and a sterile cloth apron loosely suspended under the abdomen protects the vaccinated area. A sheet of adhesive plaster attached to the buttocks and falling over the "breeching" prevents soiling of the latter. No discomfort is caused the animal by this restraint, as it can rest in the sling.

In addition to keeping the area as clean as possible, special care has also been taken in the process of cleansing, both before vaccination and before curetting. The following procedure is repeated three separate times: sterile water and sterile castile soap solution are first used to produce a thick lather, which is followed by the vigorous use of a sterile brush. Then comes thorough irrigation with sterile water, followed by drying with a sterile towel. Seventy per cent. alcohol is applied to finish the cleansing, but before curetting the alcohol is omitted to avoid injury to the virus. Before operating, sterile towels saturated with 1 per cent. solution of an alkaline cresol germicide are spread around the vaccinated area, and the rules of surgical asepsis carefully observed.

Each lot of vaccine virus is tested for potency and purity. These tests are carried on by Dr. Kohn, Dr. Rosenau and Dr. Reagh.

Calves inoculated and Vaccine produced Dec. 1, 1915, to Dec. 30, 1916.

WHEN RECEIVED.	Number of Calves.	Designation.	YIELD OF VACCINE.	
			Cubic Centimeters.	⅟60 Cubic Centimeter Doses.
1915.				
December 7,	3	493[1]	80	4,800
		494[1]	100	6,000
		495[1]	70	4,200
December 28,	2	496	90	5,400
		497	110	6,600
1916.				
January 11,	2	498[2]	–	–
		499	60	3,600
February 1,	2	500	80	4,800
		501	95	5,700
February 29,	2	502	110	6,600
		503	110	6,600
April 11,	2	504	105	6,300
		505	105	6,300
May 9,	2	506	115	6,900
		507	110	6,600
October 11,	1	508	115	6,900
October 24,	1	509	90	5,400
Totals,	17	–	1,545	92,700

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[1] Vaccine not used on account of autopsy findings.

[2] Vaccine not taken on account of injury to foot.

REPORT OF THE ANTITOXIN AND VACCINE LABORATORY, FOREST HILLS, MASS.

RUDOLPH KOHN, M.D., ASSISTANT DIRECTOR.

Treatment and immunization of the diphtheria antitoxin horses were continued along the same lines as reported the previous year. With unimportant changes, the method introduced a year and a half ago has given good results.

The method of immunization of the antimeningitis horses was changed from intramuscular to intravenous injection, with gratifying outcome.

The number of horses in the stables on Dec. 1, 1915, was 23; the number acquired during the fiscal year was 13.

Twelve horses were disposed of; 6 were chloroformed and bled; 3 were exchanged as unsuitable for our work; and 3 died, with the following findings: —

One horse fell in the icy yard, rupturing a blood vessel; 1 died from the effects of toxin; and 1 was shot owing to an injury of the foot.

The demand for diphtheria antitoxin has decreased slightly, owing to a decrease in the number of clinical cases of the disease, probably due to the educational campaign of the State Department of Health, and also to the general preventive measures followed to check the poliomyelitis epidemic.

The average strength of the distributed diphtheria antitoxin has been somewhat higher than last year, as more serum has been concentrated. It is our earnest wish to concentrate all the serum, in order to lessen the severity of the serum sickness accompanying the injection of antitoxin.

The stock of diphtheria antitoxin on hand is sufficient to last about nine months under ordinary circumstances.

A considerable increase must be noted in the demand for antimeningitis serum. There is sufficient stock of this on hand to last about one year.

The following tables will give the details in regard to the production and distribution of diphtheria antitoxin and antimeningitis serum: —

General Summary.

Number of horses on hand Dec. 1, 1915: —	
Antimeningitis,	4
Diphtheria antitoxin,	19
Total,	23
Number of horses acquired Dec. 1, 1915, to Nov. 30, 1916,	13
Number of horses disposed of Dec. 1, 1915, to Nov. 30, 1916,	12
Number of horses on hand Nov. 30, 1916: —	
Antimeningitis,	4
Diphtheria antitoxin,	16
Antipneumococcus,	4
Total,	24

Production and Distribution.

Diphtheria antitoxin: —	
Number of liters of diphtheria antitoxin distributed Dec. 1, 1915, to Nov. 30, 1916,	548.2
Number of 1,000-units distributed during the year,	174,435
Number of liters on hand Nov. 30, 1916,	660.0
Number of 1,000-units on hand Nov. 30, 1916,	132,000
Antimeningitis serum: —	
Number of liters on hand Dec. 1, 1915,	26,675
Number of liters produced Dec. 1, 1915, to Nov. 30, 1916,	27,800
	54,475
Number of liters distributed Dec. 1, 1915, to Nov. 30, 1916,	26,440
Number of liters loss,	1,080
Number of liters on hand Dec. 1, 1916,	26,955
	54,475
General distribution of diphtheria antitoxin: —	
Number of 1,000-units in 750-unit packages,	5,850
Number of 1,000-units in 1,500-unit packages,	16,800
Number of 1,000-units in 2,000-unit packages,	840
Number of 1,000-units in 3,000-unit packages,	119,193
Number of 1,000-units in 6,000-unit packages,	2,184
Number of 1,000-units in 12,000-unit packages,	28,524
Number of 1,000-units in 18,000-unit packages,	1,044
Total number of 1000-units sent out,	174,435
Number of liters of serum distributed to State,	548.2

WASSERMANN LABORATORY.

WILLIAM A. HINTON, ASSISTANT DIRECTOR.

According to the last annual report the organization of the Wassermann Laboratory consisted of a director, an assistant director, a technician, a stenographer and a laboratory attendant. During the present year this staff has been increased by a stenographer and an additional laboratory attendant.

WASSERMANN TEST.

The first report was based on the work done by the Wassermann Laboratory during the first six months of its existence. The present report covers the next twelve months (Dec. 1, 1915, to Nov. 30, 1916) during which time 25,497 specimens were examined by the Wassermann test. Of this number, 24,406 are classified in Table I.

TABLE I. — *Institutions and Physicians served and the Number of Specimens from these Sources.*

NUMBER OF INSTITUTIONS AND PHYSICIANS SERVED.	1914-15 (Six Months).	1915-16 (Twelve Months).	NUMBER OF SPECIMENS.	
			1914-15 (Six Months).	1915-16 (Twelve Months).
State institutions,	15	21	6,350	14,685
Municipal and private institutions,	27	53		7,325
Physicians,	110	514	142	2,396
Total,	–	–	6,492	24,406

Table I. indicates the growth of Wassermann work for institutions and physicians. While there has been a substantial growth in the number of institutions served, the large increase has been in the number of physicians. This growth in the number of physicians who are using the facilities offered by the State is due to the fact that it has been made easier for them to obtain the services of the Wassermann Laboratory through co-operation with local boards of health. During the year 1915–16, 58 local boards were thus co-operating with the Wassermann Laboratory, as compared with only 8 during the previous year. This is gratifying because the local boards of health should constitute the agencies for the distribution of Wassermann service under such regulations and directions as the State Department of Health prescribes.

It will be noted in Table I. that there are at present 514 physicians who have availed themselves of Wassermann service. Although this is a noteworthy increase, it is recommended that not only more physicians use this valuable test as an aid in the diagnosis of syphilis, but that they make more frequent use of it. The total statistics of the Wassermann Laboratory show that roughly 15 per cent. of all the patients examined are syphilitic, while Table II. shows that 28.5 per cent. of specimens submitted by private physicians give a positive reaction and 6.8 per cent. give a doubtful test. This would indicate that the test is being used by physicians only on cases strongly suspected of the disease or on patients who are being treated for it. It is recommended that physicians use the Wassermann test as part of their routine medical examination. Many cases of syphilis which are not suspected would be discovered in this way. The statistics of the laboratory show that 55 per cent. of those infected are discovered by making a routine Wassermann examination. Table II. gives an analysis of the specimens received from physicians.

How Physicians may obtain the Services of the Wassermann Laboratory. — As the policy now stands physicians may obtain Wassermann service when specimens are submitted by direction of their State District Health Officer or their local board of health; or patients may be sent directly to the laboratory, where specimens of blood are taken on Tuesdays and Thursdays between 3 and 5 P.M., at other times only by special appointment.

TABLE II. — *Analysis of Specimens from Physicians.*

SPECIMENS FROM PHYSICIANS SUBMITTED BY DIRECTION OF —	RESULTS OF THE WASSERMANN TEST.					
	Positive.	Doubtful.	Negative.	Unsatisfactory.	Containers broken in Transit.	Total.
1. State District Health Officers, . .	95	21	148	31	20	315
2. Local boards of health, . . .	222	59	390	102	58	831
3. Wassermann Laboratory (directly), .	301	71	640	12	–	1,024
4. Wassermann Laboratory (indirectly),	67	14	101	32	12	226
Totals, ...	685	165	1,279	177	90	2,396
Per cent., ...	28.5	6.8	53.3	7.3	3.7	–

Unsatisfactory Wassermann Tests — Remedy. — It is regrettable that such a large percentage of the specimens of blood submitted by physicians for a Wassermann test through other channels than the Wassermann Laboratory directly give an "unsatisfactory" test, or the tubes containing them are broken in transit. Even when the glass containers are not broken in transit, the specimens of blood are hemolyzed, due in large measure to the shaking received during their transportation through the mail. Wherever the facilities of the local boards of health permit, it is recommended that the serum be separated from each specimen of blood and submitted as such. By such treatment hemolysis cannot occur. It would be comparatively easy for the agent of each local board of health to send one of its representatives to the Wassermann Laboratory to learn the technique of withdrawing the serums. A single day so spent would be of great advantage to the physicians whom these boards of health serve.

The above recommendation is made because the art of withdrawing serums and properly preparing them for shipment is not without its pitfalls. One institution which submits its specimens as serums frequently fails to observe some essential detail, and as a consequence a satisfactory test cannot be made. Inasmuch as such a flaw in the technique of preparing the serums can be easily recognized in the Wassermann Laboratory, where a number of serums are received from one source, only the disadvantage of having to rebleed the patients results. On the other hand, if the physician himself should make a similar mistake on a single specimen it might not be recognized in the Wassermann Laboratory, and as a result an unreliable report might be given. "Unsatisfactory" reports are alike inconvenient to both patient and physician. As many as three consecutive unsatisfactory reports have been given to a physician on a single patient because the specimens of blood were hemolyzed when received. This caused a delay of several weeks in reaching a diagnosis. Oftentimes such a delay is a serious matter, especially where immediate surgical treatment depends upon a prompt Wassermann report.

DIAGNOSTIC EXAMINATIONS FOR THE DEPARTMENT OF ANIMAL INDUSTRY.

On May 1, 1916, the Department of Animal Industry formally transferred its laboratory diagnostic examinations to the State Department of Health. This work is now being carried on in the Wassermann Laboratory, and necessitated the employment of the additional laboratory attendant.

Complement Fixation Tests for Glanders. — The largest number of examinations are complement fixation tests for glanders. This test is a complicated biologic reaction to discover specific antibodies in horses' serum when they are infected with glanders. The principles involved in the test and the materials used are almost identical to those employed in the Wassermann Reaction. For these reasons the work is being done more economically than formerly.

Diagnostic Examination for Rabies. — For this examination parts of the Ammon's horns and of the cerebellum are selected from the brain of the suspected animal. Impression preparations made from these parts are stained according to Bonn's modification of the Mann stain and by Frothingham's method. A report of the result of the microscopic examination of these stained impression preparations is sent to the following State officials: the Commissioner of the Department of Animal Industry, the director of the Division of Communicable Diseases of the State Department of Health, and to the State District Health Officer in the district where the suspected animal was found.

In addition to this first examination of impression preparations, pieces of Ammon's horn and of the cerebellum, together with the Gasserian ganglia, are appropriately fixed, stained and examined microscopically for the characteristic changes found in rabies. As a final test an emulsion of the brain of every animal submitted for examination is made in neutral glycerine and injected subdurally into a rabbit. The parts selected for this purpose consist of large portions of the medulla and cerebellum and smaller pieces of other parts of the brain. The animal injected is observed for symptoms of rabies during a period of ninety days. An autopsy is made on each rabbit dying within this period to determine the presence of Negri bodies in its brain. For this purpose impression preparations are made from Ammon's horn and the cerebellum. These are stained according to Bonn's modification of the Mann stain and by Frothingham's method.

Rabies a Public Health Problem. — Although hydrophobia (in human beings) is not a relatively common disease in Massachusetts, the symptoms which it produces are so severe and so surely fatal that its prompt diagnosis is properly a public health problem. When the diagnosis of rabies is made on an animal which has bitten or in any way broken the skin of a person the Pasteur treatment can be given promptly. This treatment when administered in time will prevent the disease from developing in a large proportion of cases. During the past ten years 33 deaths have been reported in Massachusetts as being caused by this infection. The following table gives a complete analysis of the examination for rabies during the period from May 1, 1915, to Nov. 30, 1916: —

TABLE III. — *Analysis of Rabies Examinations, together with History of Animals examined.*

	RESULT OF EXAMINATION FOR RABIES.		
	Positive.	Negative.	Unsatisfactory.
History of animal examined.	9 dogs each bit 1 person. 1 dog bit 2 persons. 1 dog bit 3 persons.	3 dogs each bit 2 persons. 8 dogs each bit 1 person. 1 dog bit 3 persons. 2 dogs each scratched 1 person.	2 dogs each bit 1 person.
	2 dogs injured nobody.	11 dogs injured nobody. 2 cows injured nobody. 2 cats injured nobody.	3 dogs injured nobody.
Total, . . .	11 dogs bit 14 persons and 2 dogs injured nobody.	14 dogs bit or scratched 19 persons and 15 animals injured nobody.	2 dogs bit 2 persons and 3 dogs injured nobody.

From Table III. it will be noted that two of the five dogs, where the examination was unsatisfactory, bit persons. These examinations were unsatisfactory because the material submitted reached the Wassermann Laboratory in such an advanced stage of decomposition that no successful test could be made.

Directions for Persons bitten by Domestic Animals. — Inasmuch as a correct diagnosis is so important, any animal (especially a dog or cat) which bites an individual should be kept in quarantine, if this is at all possible, until examined by a veterinarian, preferably from the State Department of Animal Industry. If danger of being bitten by the animal prevents this, and it is killed, this fact should be immediately telephoned to the Department of Animal Industry, and the proper directions for packing and shipping the head of the animal be obtained there. In this way the specimens would reach the Department of Animal Industry fresh, when the best examination is possible. These precautions are imperative during the summer months when decomposition begins within a few hours after death.

A complete list of the diagnostic examinations for the Department of Animal Industry is included in Table IV.

TABLE IV. — *Diagnostic Examinations for the Department of Animal Industry.*

	RESULT OF EXAMINATION.				
	Positive.	Doubtful.	Negative.	Unsatisfactory.	Total.
Complement fixation tests for glanders,	154	95	732	4	985
Diagnostic examination for rabies,	13	–	29	5	47

Miscellaneous examinations: —

For staphylococcus septicæmia,	1
For hemorrhagic septicæmia,	1
For anthrax bacilli in tissue,	6
For œsophagostomum columbianum in sheep's intestines,	1
For glanders bacilli in tissue,	1
	10

Total examinations, 1,042.

NEW EQUIPMENT.

On account of the rapid growth of the Wassermann Laboratory, additional equipment was required. To meet these requirements two copper incubators, a large autoclave, a rotary microtome, an animal table and a number of less expensive pieces of apparatus were purchased. In addition to these purchases certain alterations were made in the laboratory in order to separate the clerical from the laboratory work. The extent of the clerical work can be gauged by the fact that over $200 was expended for stamps and stamped envelopes to mail the reports and other communications directed from the Wassermann Laboratory. In addition to this clerical work considerable time is required to maintain adequate records of each specimen examined.

RÉSUMÉ.

The past year's work concerned itself largely in perfecting the organization established during the previous six months, and in organizing the new work for the Department of Animal Industry. In addition to this, however, 965 spinal fluids were examined by a special Wassermann method for a number of institutions for the insane. This method of titrating the strength of the antibody content in spinal fluids has proved useful to these institutions, and for this reason warrants the considerable extra time involved in the special test.

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